WASTE MANAGEMENT

Prepared For:

WASTE MANAGEMENT, INC.
8000 Chambers Road
Charles City, Virginia 22485

APPLICATION FOR PROJECT XL:
Environmental Excellence And Leadership
LANDFILL BIOREACTOR SYSTEMS

KING GEORGE COUNTY LANDFILL AND RECYCLING CENTER *And* MAPLEWOOD RECYCLING AND WASTE DISPOSAL FACILITY, VIRGINIA WASTE MANAGEMENT, INC.

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1. INTRODUCTION TO THE AGREEMENT

1.1. Description of the Project and Its Purpose

This document contains the details of the Final Project Agreement (FPA) between Waste Management, Inc. (WM) and the United States Environmental Protection Agency (USEPA) for implementing different bioreactor operations at the Maplewood Recycling and Waste Disposal Facility in Amelia County, Virginia and King George County Landfill and Recycling Center in King George County, Virginia. This document also contains details of the project and the expected benefits of the project. The general locations of the two facilities are shown on Figure 1. WM's intent to pursue this project was initially communicated to Ms. Elizabeth Termini of the USEPA in a letter from the Virginia Department of Environmental Quality (VADEQ) dated 15 February 2000. As part of the project WM is requesting that USEPA grant regulatory relief from the requirement of the Resource Conservation and Recovery Act (RCRA) that prohibits application of bulk liquids in municipal solid waste landfills, as presented in Title 40 of the Code of Federal Regulations (40 CFR) Section 258.28. and alternative linear requirements

Under this project, bioreactor programs would be implemented at the Maplewood Recycling and Waste Disposal Facility (Maplewood Landfill) and the King George County Landfill and Recycling Facility (King George County Landfill). The purposes of implementing the bioreactor programs would be to increase the rate of biodegradation in the landfills and to facilitate the management of leachate and other liquid wastes. The primary goal of the project would be to evaluate the relative improvement in landfill performance between the two different bioreactors proposed. It is expected that operation of these landfills, as described in this proposal, would result in several environmental and cost-saving benefits. It is also anticipated that the information obtained will provide the USEPA and the waste disposal industry with data supporting the use of bioreactors as an integral part of long-term operations at these and other municipal solid waste (MSW) landfill sites throughout the United States.

In the remainder of this section, a description ~~of~~ the facilities is presented, contacts for the project are identified, and the organization of a Final Project Agreement (FPA) is described. In general, this FPA follows the organization provided in the document entitled, *"Project XL: Best Practices for Proposal Development"* [USEPA, 1999] as well as published guidelines for FPA's. The information on Table 1 identifies the location where the specific requirements of the XL Program documents are addressed in this application.

1.2. Description of the Facility and Facility Operations/Community/ Geographic Area

The Maplewood Landfill is located in Amelia County, Virginia, approximately 30 miles southwest of Richmond, Virginia. The landfill liner area will cover a total area of about 404 acres upon completion. Construction of the first phases started in 1992. Construction of the most recent phase was completed in 1997. The King George County Landfill is located in King George County, Virginia, approximately 50 miles north-northeast of Richmond, Virginia. The landfill liner area will be cover about 290 acres upon completion. The first phase of liner system construction began in 1996. Construction of additional liner system area has been performed every year since 1996.

Both the Maplewood Landfill and the King George County Landfill were constructed having geomembrane double-liner systems, with primary leachate collection and leak detection (secondary collection) layers. The liner systems for the two landfills are illustrated on Figure 2. Because these landfills were constructed having double-liner systems, they provide a high level of protection to the environment against potential impacts caused by leakage of leachate. The design for both landfills exceeds the requirements for municipal solid waste landfills contained in 40 CFR 258 (i.e., Subtitle D). Therefore, these landfills are excellent candidates for the bioreactor programs that are proposed in this application. The proposed project has been discussed with involved parties, such as the USEPA, WM, and the host counties, as well as the participants identified in Section 3.3. The parties agree that the project would be valuable, as demonstrated by letters of support for the project from the Amelia County and King George County Boards of Supervisors.

1.3. Purpose of the Agreement

This FPA is a joint statement of the plans, intentions, and commitments of the USEPA, the Commonwealth of Virginia, Amelia and King George Counties, and WM to carry out this project, ~~to be approved for implementation at the Maplewood and King~~

~~George County Landfills~~. This Project will be part of WM's Project XL Program to develop innovative approaches while providing superior environmental protection.

The FPA does not create legal rights or obligations and is not an enforceable contract or a regulatory action such as a permit or a rule. This applies to both the substantive and the procedural provisions of this Agreement. While the parties to the Agreement fully intend to follow these procedures, they are not legally obligated to do so. For more detail, please refer to Section 6 (i.e., Legal Basis for the Project).

Federal and State flexibility and enforceable commitments described in this Agreement will be implemented and become effective through a legal implementing mechanism, such as a rule modification or permit issued by the Commonwealth of Virginia.

All parties to this Agreement will strive for a high level of cooperation, communication, and coordination to assure successful, effective, and efficient implementation of the Agreement and the Project.

1.4. List of the Parties that Will Sign the Agreement

The Parties to this Final Project XL Agreement are the USEPA, WM, and the VADEQ., (the counties).

1.5. List of the Project Contacts

The parties involved in the development and preparation of this proposal are identified below.

State Regulatory Liaison: Mr. E. Paul Farrell
Environmental Engineer Consultant
Virginia Department of Environmental Quality
629 East Main Street
Post Office Box 10009
Richmond, Virginia 23219

Project Manager:	Mr. James W. Stenborg, P.E. Regional Engineer Waste Management, Inc. King George County Landfill 10376 Bullock Drive King George, Virginia 22485 (540) 775-3123
Maplewood Landfill Manager:	Mr. Lee Wilson District Manager Charles City County Landfill 8000 Chambers Road Charles City, Virginia 23030 20221 Maplewood Rd. Jetersville, VA 23083
King George County Landfill Manager:	Mr. Timothy J. Schotsch District Manager King George County Landfill 10376 Bullock Road King George, Virginia, 22485
Project Engineer:	Michael F. Houlihan, P.E. Principal GeoSyntec Consultants 10015 Old Columbia, Road, Suite A-200 Columbia, Maryland 21046
Other Key Waste Management, Inc. Personnel:	John A. Baker Director, Environmental Assessment and Technology Greg Cekander, P.E. Vice President of Engineering

2. DETAILED DESCRIPTION OF THE PROJECT

2.1 Summary of the Project

2.1.1 Overview

This project involves the operation of two landfills with bioreactors for the purpose of evaluating the relative benefits of the addition of liquids in a controlled manner. The viability of these methods is supported by several other applications of the bioreactor technology throughout the United States. A summary of some of these projects is presented on Table 2 and the benefits of these technologies are summarized on Table 3. As part of the project, WM will be granted regulatory flexibility from the RCRA requirement that prohibits application of bulk liquids in municipal solid waste landfills, as presented in 40 CFR Section 258.28. In the past, the design goal of a "traditional" landfill was to minimize the quantity of water introduced into the landfill, thus minimizing leachate generation. The disadvantage to this approach is that the lack of liquid causes the biodegradation process to occur very slowly, thus leaving waste in a relatively undecomposed state for a long period. In this case, waste continues to be a potential source of groundwater contamination throughout the post-closure period. Because biodegradation occurs slowly, the liner system is potentially exposed to leachate for a relatively long period of time.

Liner requirement also.

what else will be added

Under the XL program, WM will operate the Maplewood Landfill and the King George County Landfill as bioreactor landfills. The Maplewood bioreactor will involve addition of, primarily, leachate generated at the facility. The King George bioreactor will involve addition of leachate generated at this facility plus other liquids, such as non-hazardous liquid waste or stormwater. A conceptual process diagram for a landfill bioreactor is presented on Figure 3. The Maplewood and King George County Landfills are located in the same geographic area and receive similar waste streams. Operating these landfills using two different application rates will allow the relative performance and cost-saving benefits of the two bioreactor approaches to be compared. The waste received at these landfills is primarily municipal solid waste having a small percentage of non-degradable products (e.g., construction debris). WM understands that the high percentage of biodegradable waste in these landfills makes this proposed program desirable as compared to other bioreactor programs currently being considered by USEPA for Program XL. In the absence of Project XL, these landfills would continue to operate under currently permitted procedures, which do not include the use of bioreactor technologies (such as liquid application).

2.1.2 Process Description – Maplewood Landfill Bioreactor

The landfill bioreactor program that will be implemented at the Maplewood Landfill involves application of leachate from the landfill and ~~small~~ quantities of other liquids to the waste. The primary purposes of recirculating leachate in this manner is to treat the leachate and to increase the rate of biological degradation of waste in a portion of the landfill where liquids are applied. The potential benefits of the bioreactor are presented in Table 3. Treatment of leachate occurs within the waste when the microbes that naturally exist in the landfill consume portions of the leachate and waste material. Several studies (including some described in Table 2) have shown that leachate quality improves over time when leachate is recirculated on a regular basis. As an example, Table 4 and Figure 4 show leachate quality improving over a period of about seven years at test cells operated by the Delaware Solid Waste Authority's Central Solid Waste Management Center (CSWMC). Recirculation of leachate can also result in accelerated generation of landfill gas; an example of accelerated landfill gas generation for the two test cells at CSWMC is presented on Figure 5. Further, at bioreactor landfills, substantial settlement of the waste typically can occur during the operating life of the landfill, thus stabilizing the waste mass and reducing the need for long-term maintenance during the post-closure care period. This settlement can significantly increase the usable waste disposal capacity compared to the facility's original design capacity. Most importantly, bioreactor processes reduce the time needed to achieve a stable waste mass after closure. Finally, because the waste mass is more stable, it has more potential end-uses.

I thought this was only re-circulation

2.1.3 Process Description – King George County Landfill Bioreactor

The bioreactor program that will be implemented at the King George County Landfill involves applying a quantity of liquid that is about twice that applied at the Maplewood Landfill. In this landfill bioreactor, conditions will be established that are intended to significantly increase the rate of degradation of waste during the operating life of the landfill to achieve the benefits identified in Table 3. Although the process of recirculating leachate provides much of the moisture needed to maximize biological degradation of waste, studies have shown that the quantity of liquid needed to maximize biodegradation is much greater than the quantity of leachate generated at most landfills (see, for example, Figure 5). At the King George County Landfill, sources of liquid other than leachate will be used to supply the additional quantity of liquid needed. These sources may include stormwater, wastewater treatment sludges, or other biota-rich liquid wastes. For this project, a controlled amount of leachate, stormwater, and non-hazardous liquid wastes will be added to the bioreactor test area, as discussed in Section 2.2.2.

2.2 Specific Project Elements

2.2.1 Maplewood Landfill Bioreactor System

2.2.1.1 Overview

In this section, the proposed bioreactor system for the Maplewood Landfill is described. In general, the system is designed to distribute leachate throughout the nominal 10-acre test area as uniformly as possible and to maintain the moisture content of waste at a level high enough to increase biodegradation. The total footprint is about 48 acres as of May 2000. The detailed design of the system is presented in the design report [GeoSyntec, 2000a]. In this section, a brief summary of the design is presented to illustrate the features of the proposed project. The information presented in this section is also referenced in Section 3 (i.e., Project XL Criteria) to describe the manner in which the proposed program complies with the Project requirements of superior environmental performance. First, in Section 2.2.1.2, the bioreactor system layout and design is described. In Section 2.2.1.3, the typical methods for construction of the system are described. Finally, in Sections 2.2.1.4 and 2.2.1.5, proposed methods for monitoring and data analysis/reporting are described.

2.2.1.2 Bioreactor System Layout and Design

The proposed study area will be Phases 1, 2, 3, 4, and 11. In Phases 1 and 2, liquid will be applied in trenches; Phases 3, 4, and 11 will be used as test cells and no liquid will be applied; only a portion of the rainfall that naturally falls and percolates into the waste will enter the waste in these phases. The goals of the design for the system will be the following:

Does this mean no other liquid will be added?

- recirculate all of the leachate generated at the facility (i.e., up to about 4,000,000 gallons per year);
- uniformly distribute leachate throughout the waste mass in the test (i.e., liquid application) area;
  minimize the potential for the occurrence of seeps by placing distribution structures at least 50 feet from the crests of slopes;
- evaluate the relative effectiveness of different horizontal trench designs for uniformly distributing leachate throughout the waste mass;
- identify several leachate delivery options to simplify operations;
- provide monitoring features within the horizontal trenches so that liquid head and distribution rate within the trenches can be measured and documented; and
- manage landfill gas during liquid application events using an active landfill gas collection and control system, and enhancing landfill gas collection and control system components if the air quality permit limits are exceeded.

The manner in which these goals are addressed in this application are summarized on Table 5. The design of the Maplewood bioreactor system is based on analytical methods developed by Maier, et. al., [1998. In general, the design was developed based on the following considerations.

- *Leachate Application Quantity and Rate.* As described above, the goal for the Maplewood Landfill is to recirculate as much leachate as is generated at the facility. Based on facility records, the facility generated approximately

3,000,000 gallons of leachate in 1999, which was a relatively dry year. Under this XL program, between 3,000,000 and 4,000,000 gallons of liquid would be applied per year. The liquid application rate would be 10,960 gallons per day, based on an application rate of 4,000,000 gallons per year. A portion of the liquid added could consist of liquids other than leachate, if the leachate quantity is relatively low; such "other liquids" could include non-hazardous liquids such as waste water treatment plant sludges, stormwater or truck washwater. This will require reg flex for the additional liquids the same as King George

- *Head on Liner*. The impact of the proposed liquid application activities on the depth of liquid on the liner system was evaluated using the HELP model. First, the hydrologic evaluation was performed assuming that no liquid is applied; then, the evaluation was performed for the liquid application condition under the conservative assumption that 4,000,000 gallons per year is recirculated. The resulting thickness of head on the liner system is less than the regulatory maximum of 12 in.

- *Application Capacity of System*. The "application capacity" of the system is the amount of liquid that can be expected to flow by gravity from all of the trenches. For the Maplewood Landfill, this quantity has been estimated using the methodology described by Maier [1998]. This method involves estimating the moisture content of the waste (typically 15 to 25 percent without liquid application), the hydraulic properties of the waste, the moisture retention capacity (field capacity) of the waste (typically 40 percent), and the head of liquid on the trench. Using this information, the flowrate of liquid out of one trench into the waste is calculated; the total application capacity equals the combined flowrate of all trenches. As shown in [GeoSyntec, 2000a], the total flowrate capacity of the group of trenches is calculated to be about 110,000 gallons per day, which is much greater than the proposed average rate of 10,960 gallons per day application rate.

- *Leachate Storage Capacity of On-Site Structures*. It is important that the on-site leachate storage structures have enough capacity to store leachate that is needed for later application to the trenches. Liquid will be collected and stored for application when conditions are appropriate (i.e., it is not raining). The storage capacity of the leachate tanks at the Maplewood Landfill is approximately 500,000 gallons, which is the average amount of leachate generated over a period of about two months. During operation of the bioreactor system, leachate storage structures will be used to temporarily store leachate at times when it is not or cannot be recirculated. As a minimum, the tanks will need to store the quantity of leachate generated over a period of several days; this is much less time than the approximately two months of storage capacity at the site. Therefore, the facility has adequate leachate storage capacity for operation of the bioreactor system [GeoSyntec, 2000a]. As a contingency during times when leachate generation exceeds the rate of recirculation in and storage capacity, leachate can be hauled off-site.

- *Landfill Gas Control System.* To meet the requirements of Section 3.2.1.4 (Potential Environmental Impact to Air), it is important that the landfill be operated in a manner that meets the requirements of all applicable air quality state and Federal permits. As shown in the design report [GeoSyntec 2000a], because the Maplewood Landfill must comply with the requirements of 40 CFR Subpart WWW and other air quality regulations, an active landfill gas collection system will be operated at all times, including during liquid application events. The Maplewood Landfill currently has an active landfill gas collection system that is in operation; if odor problems or air quality problems occur, then the system will be expanded as needed (e.g., using additional extraction wells or trenches or by placing less permeable cover and affected areas). The system performance will be documented through routine monitoring of the landfill gas for the presence of methane and other constituents.

2.2.1.3 Liquid Application System Construction

The liquid application system will be constructed using typical trench construction methods and other methods developed during the implementation of the program. The construction methods are described in detail the design report [GeoSyntec, 2000a]. The goals of the construction methods presented in the report one:

- provide commonly used methods that can be implemented by landfill personnel or earthwork contractors during normal operations;

- use materials of construction that are readily available, inexpensive, and resistant to degradation by the pressures and chemical constituents present in the landfill; and

- minimize the occurrence of odors or other nuisances during construction of the liquids application system.

2.2.1.4 Monitoring

To verify that the goals of the program and the Final Project Agreement are met, the landfill will be monitored. The specific goals of the monitoring program will be:

- to measure leachate quality in areas with and without liquid addition over time;

- measure the total quantity of leachate collected in areas with and without liquid application and the quantity of leachate or other liquids applied in the test areas;

- monitor the rate that leachate can be applied to the trenches without causing seeps or other potential operational problems;

- monitor the ground surface of the entire site, including the liquid application area, for the presence of landfill gasses (i.e. methane, NMOCS, etc.,) in excess of permit limits, and evaluate the need for additional landfill gas collection components (i.e., wells and header pipe) during liquid application events to improve the effectiveness of the landfill gas collection system; and

- measure the settlement of the waste over the entire landfill area, including the liquid application area; this will include semi-annual or more frequent topographic surveys.

The methods that will be used to monitor these parameters are described on Table 6. To simplify the monitoring of these parameters, forms will be generated for use by operations personnel to collect and track this information.

2.2.1.5 Data Analysis and Reporting

The data collected during monitoring events described in Section 2.2.1.4 will be analyzed for the following trends:

- changes in leachate quality on an annual basis;
- relationship between total quantity of leachate generated and liquid applied in the phases of the landfill;
- range of liquid application rates or qualities to various trenches and potential problems arising from certain application rates;
- compliance with the requirements of the Air Quality Permit for the site, including monitoring the ground surface for the occurrence of non-methane organic compounds (NMOCs) and methane;
- relative performance of the trenches and evaluate an appropriate trench spacing that is needed to uniformly distribute leachate throughout the waste mass;
- occurrence of seeps and whether they are attributable to operation of the liquid application system; and
- quantity of settlement of landfill surface settlement is areas with and without liquid injection. SP in

The manner in which these data will be summarized and reported is outlined in Section 3.1.3.

2.2.2 King George County Landfill Bioreactor System

2.2.2.1 Overview

In this section, the proposed landfill bioreactor system for the King George County Landfill is described below. In general, the system will be designed to distribute liquids as uniformly as possible throughout the test area of the waste mass, and to establish moisture contents within the test area at a level high enough to significantly increase biodegradation. The detailed design of the system is presented in King George design report [GeoSyntec, 2000b]. In this section, a brief summary of the design is presented to illustrate the features of the proposed project. The information presented in this section is used in Section 3 (i.e., Project XL Criteria) to describe the manner in which the proposed program complies with the Project XL requirements of superior environmental performance. First, the landfill bioreactor system layout and design is described. Then, in Section 2.2.2.3, the typical methods for construction of the system are described. Finally, in Sections 2.2.2.4 and 2.2.2.5, proposed methods for monitoring and data analysis/reporting are described.

2.2.2.2 Bioreactor System Layout and Design

A conceptual process flow diagram for operation of the bioreactor is presented on Figure 3. The overall study area will be established within the MSW Cells 2, 3, and 4 of the King George County Landfill. Liquid will be applied in Cell 3; Cells 2 and 4 will be the control cells in which no liquids will be applied. The overall study area, (i.e., Cells 2, 3, and 4) covers about 59 acres. Cell 1 is currently under construction (July 2000) and will be a future control area. The goals of the design for the bioreactor will be the following:

- recirculate all of the leachate generated at the facility (i.e., up to about 8,000,000 gallons per year plus additional liquid so that the total liquid application rate is about 8,000,000 gallons per year);
- uniformly distribute leachate throughout the waste mass in the test area (i.e., liquid application);

- minimize the potential for the occurrence of seeps by placing distribution structures at least 50 feet from the crests of slopes;

- evaluate the relative effectiveness of liquids in promoting degradation by monitoring surface settlement by cell areas and noting which types of liquids have been applied in those areas;

- identify several leachate delivery options to simplify operations;

- provide monitoring features within the liquid application structures so that leachate head and distribution rate within the trenches can be monitored effectively; and

- manage landfill gas during liquid application events using an active gas collection and control system, and enhance the gas collection and control components if air quality permit limits are exceeded.

The manner in which these goals are addressed are summarized on Table 3. The design of the system will be based on analytical methods developed by Maier, et. al. [1998] as described in Section 4 of the design report [GeoSyntec, 2000b]. In general the design was based on the following primary considerations.

- *Liquid Application Quantity and Rate.* As described above, the goal for the King George County Landfill is to recirculate as much leachate as is generated at the facility and to apply additional liquid to make the total amount of liquid applied equal to between 7,000,000 and 8,000,000 gallons per year. Based on facility records for the past three years, the facility generates approximately 3,500,000 gallons of leachate per year. Based on estimates of stormwater runoff quantities and the storage capacity of the stormwater management ponds at the site, approximately 8,000,000 gallons or more of stormwater can be made available for application to the landfill waste. The liquid application rate would be, on average, about 22,000 gallons per day based on an estimated application rate of 8,000,000 gallons per year.

- *Head on Liner.* The impact of the proposed liquid application activities on the head of liquid on the liner system was evaluated using the HELP model. First, the hydrologic evaluation was performed assuming that no leachate is recirculated; then, the evaluation was performed for the leachate recirculation condition under the conservative assumption that 3,500,000 gallons/year of leachate is recirculated. The analysis is shown in Appendix A to the design report [GeoSyntec, 2000b]. As shown in the Design Report [GeoSyntec 2000b], the resulting head on the liner system of 10 in., which is less than the regulatory maximum thickness of 12 in.

- *Application Capacity of System.* The "application capacity" of the system is the amount of liquid that can be expected to flow by gravity from all of the trenches. For the King George County Landfill, this quantity has been estimated using the methodology described by Maier [1998]. This method involves estimating the moisture content of the waste (typically 15 to 25 percent without liquid application), the hydraulic properties of the waste, the moisture retention capacity (field capacity) of the waste (typically 40 percent), and the head of liquid on the trench. Using this information, the flowrate of liquid out of one trench into the waste is calculated; the total application capacity equals the combined flowrate of all trenches. As shown in the design report [GeoSyntec, 2000b], the total flowrate capacity of the group of trenches is calculated to be about 110,000 gallons per day, which is much greater than the proposed 22,000 gallons per day maximum application rate.

- *Leachate Storage Capacity of On-Site Structures.* It is important that the on-site leachate storage structures have enough capacity to store leachate that is needed for future application to the trenches. Liquid will be collected and stored for application when conditioned are appropriate (i.e., it is not raining). The storage capacity of the leachate tanks at the King George County Landfill and Recycling Center is approximately 500,000 gallons, which is the average amount of leachate generated over a period of about two months. During operation of the bioreactor system, leachate storage structures will be used to temporarily store leachate at times when it is not or cannot be recirculated. As a minimum, the tanks will need to store the quantity of leachate operated over a period of several days; this is much less time than the approximately two months of storage capacity at the site. Therefore, the facility has adequate leachate storage capacity for operation of the bioreactor system as designed in the design report [GeoSyntec, 2000b].

Landfill Gas Control System. To meet the requirements of Section 3.2.1.4 (Potential Environmental Impact to Air), it is important that the landfill be operated in a manner that meets the requirements of all applicable air quality state and Federal permits. As shown in the design report [GeoSyntec, 2000b] because the King George County Landfill must comply with the requirements of 40 CFR Subpart WWW, an active landfill gas collection system will be operated at all times including during liquid application events. The system performance will be documented through routine monitoring for the presence of methane and non-methane organic compounds.

2.2.2.3 Bioreactor Liquids Application System Construction

The liquid application system will be constructed using typical trench construction methods. The construction methods are described in detail in Section 5 of the design report. The goals of the construction methods presented in the design report are:

- provide commonly used methods that can be implemented by landfill personnel or earthwork contractors during normal operations;
- use materials of construction that are readily available, inexpensive, and resistant to the degradation by the pressures and chemical constituents present in the landfill; and
- control odors or other nuisances during construction of the liquids application system.

2.2.2.4 Monitoring

To verify that the goals of the program and the enforceable component of the Final Project Agreement are met, the leachate recirculation system will be monitored. The specific goals of the monitoring program will be to:

measure leachate quality in areas with and without liquid addition over time;

- measure the total quantity of leachate collected in areas with and without liquid application and the quantity of leachate or other liquids applied in the test areas;

- monitor the rate that leachate can be applied to the trenches without causing seeps or other potential operational problems;

- monitor the ground surface of the entire site, including the liquid application area, for the presence of landfill gasses (i.e. methane, NMOCS, etc.,) in excess of permit limits, and evaluate the need for additional landfill gas collection components (i.e., wells and header pipe) during liquid application events to improve the effectiveness of the landfill gas collection system; and

- measure the settlement of the waste over the entire landfill area, including the liquid application area, this will include semi annual topographic surveys.

The methods that will be used to monitor these parameters are described on Table 6. To simplify the monitoring of these parameters, forms will be generated for use by operations personnel in collecting and tracking this information.

2.2.2.5 Data Analysis and Reporting

The data collected during monitoring events described in Section 2.2.2.4 will be analyzed for the following trends:

- changes in leachate quality on an annual basis;

- relationship between total quantity of leachate generated and liquid applied in the test area;

- range of liquid application rates to trenches and any methods needed to attain certain application rates;

- evaluate the relative performance of the trenches and evaluate whether a closer trench spacing is needed to uniformly distribute leachate throughout the waste mass;

occurrence of seeps and whether they are attributable to the liquid application system; and

quantity of settlement of waste and estimate of total waste disposal quantity gained through settlement.

The manner in which these data will be summarized and reported is described in Section 3.1.3.

3. PROJECT XL CRITERIA

3.1. Superior Environmental Performance

3.1.1 Tier 1: Is the Project Equivalent?

3.1.1.1 Overview

The criteria for Superior Environmental Performance are identified and described in the Best Practices Guidelines [USEPA, 1999]. As shown in Section III.A of that document, the applicant must first demonstrate that the proposed project is equivalent, in terms of environmental protection, to a similar program performed within applicable regulations independent of the XL Project. The Best Practices Guidelines require a two-tiered approach to this demonstration. The first tier of the demonstration requires that the applicant quantitatively demonstrate that the proposed project results in a potential environmental impact that is equal to or less than what would occur if the project complied with all environmental regulations. The potential impacts are quantified in terms of the by-products (particularly those generated by operations related to the proposed project) that could be released to the environment. For the Maplewood and King George County Landfills, the primary (major) by-products of facility operations include leachate and landfill gas. Odors can also be released and are associated with landfill gas. Leachate can be released to the environment either below ground (i.e., through the liner system) to groundwater or above ground (i.e., through the surface of the landfill) to surface water. Landfill gas and the associated odors can be released to the environment through the liner system or through the sides or top of the landfill. Environmental media that could be impacted include groundwater, surface water, and air. Therefore, the Tier 1 evaluation presented in this section is focused on equivalent potential impacts to these three media, and is presented here for both the King George and Maplewood Landfills.

3.1.1.2 Potential Impact to Groundwater

For an environmental impact to occur to groundwater, leachate would have to migrate through the liner system of the landfill, flow vertically through the unsaturated zone, and then impinge on groundwater. As described in Section 1.2, both the

This statement might not be accurate.

Maplewood and King George County Landfills were constructed having double-liner systems, which exceed the liner performance standard of Subtitle D. These liner systems are highly efficient at preventing leakage of leachate from the landfill. The leachate collection systems of both landfills were designed to limit the thickness of leachate on the underlying liner to no more than 12 in. This has been verified with design calculations.

When liquids are applied to the landfill, there is a possibility that an increased quantity of leachate (due to the application of additional liquids) will reach the leachate collection system. Leachate head levels on the liner may also increase. However, as presented in Section 4.3 of the design reports [GeoSyntec, 2000a and 2000b] when additional liquids are applied, the thickness of leachate will not exceed 12 in. In reality, applying liquids to the waste above the leachate collection system will enhance the biological processes in the landfills, which cause more water to be consumed by landfill gas generation. This further reduces the amount of liquid that can reach the liner. For these reasons, the potential impact to groundwater will not exceed the potential environmental impact if the project were not implemented.

3.1.1.3 Potential Impact to Surface Water

For an impact to occur to surface water, leachate would have to migrate laterally from the landfill surface to an aboveground portion of the landfill sideslope and then flow downslope to a receiving waterbody. Seeps occur at landfills regardless of how well the landfill is designed and operated. There is no quantitative method to estimate the potential environmental impact to surface water caused by seeps. The surface of the landfill will be visually monitored for potential sewage areas. However, based on the operating records of the Maplewood and King George County Landfills, impacts to surface water that are attributable to seeps are mitigated before they become a problem.

is this the only method available

Potential impacts that could be caused by seeps are promptly mitigated at the Maplewood and King George County Landfills through a program of seep detection through visual inspections and of maintenance to quickly repair seeps after they are identified. This program of inspections and maintenance will continue to be implemented throughout the XL Project. Further, because of the ongoing project, site personnel will be advised to be more sensitive to the potential for seeps. Therefore, the potential environmental impact of the facility to surface water under the XL Project will at least be equal to or less than the potential environmental impact of a similar project not performed under XL.

3.1.1.4 Potential Impact to Air

inaccurate statement

For an impact to occur to air, landfill gas would have to be released from the landfill in an uncontrolled manner. For the Maplewood Landfill, active landfill gas control systems have been constructed and are currently preventing releases of gas in excess of regulatory limits. An active gas collection and control system will be installed at the King George County Landfill on or before 1 November 2000. The gas collection and control systems will be upgraded, if routine monitoring shows that the landfills' air quality permit standards have been exceeded, to control any additional gas that would be generated during liquid application. Therefore, the potential impact of the facility to air under the project will not exceed the potential impact of a similar project not performed under XL.

or before the XL Project is implemented

3.1.2 Tier 2: Superior Environmental Performance

3.1.2. Overview

The second tier for the evaluation for Superior Environmental Performance requires that the applicant demonstrate that the proposed project will result in an environmental performance that exceeds the levels of equivalence established for Tier 1. In the remainder of this section, quantitative and qualitative factors are described to demonstrate that the project represents a level of environmental performance beyond the standard for equivalence presented in Section 3.1.1.

3.1.2.2 Potential Environmental Impact to Groundwater

The proposed project will provide environmental performance that is superior to the baseline of potential environmental impacts to groundwater defined in Section 3.1.1.2 in several aspects. The five criteria used to evaluate superior performance in protecting groundwater quality, as identified in Section III.A.2 of the Best Practices

Guidelines in [USEPA, 1999] are identified below, and the manner in which superior environmental performance will be measured is provided in Section 3.1.3.

Improvements to Tier 1 Benchmarks. The Tier 1 benchmark is based on the quantity of leachate that could be released to groundwater and, as shown in Section 3.1.1.2, the proposed project is equivalent. In fact, because more liquid is consumed in a bioreactor landfill than a non-bioreactor landfill, leachate quantity at the site will eventually be less under the proposed project. In addition to leachate quantity, leachate quality is an equally important factor in evaluating the potential for impacts to groundwater quality. In bioreactor landfills, the quality of leachate over the long term is substantially better than the quality of leachate at non-bioreactor landfills, as demonstrated in Sections 2.2 and 2.3 (see Figure 4). Further, the improvement in quality will occur sooner in the life of the landfill when the reliability of the leachate containment system (i.e., the liner) is at its highest level. These factors result in a substantial long-term improvement in environmental performance and protection for the proposed project as compared to a facility operated outside of the project.

Pollution Prevention or Source Reduction. Bioreactor landfills substantially reduce the source of contamination in landfills and, thereby, significantly contribute to pollution prevention. As described in Section 2, the primary environmental threat to groundwater and surface-water quality in MSW landfills is organic constituents within the landfilled waste. By accelerating the biodegradation of these wastes, the organic constituents that represent the primary environmental threat are degraded, resulting in a reduction in the source of potential contamination and corresponding prevention of potential pollution.

Environmental Performance More Protective than the Industry Standard. The Industry Standard for protection of groundwater resources at MSW landfills in Virginia is characterized by: (i) screening waste that is received at the facility to prevent the disposal of wastes that could adversely impact groundwater quality; (ii) containing leachate within landfills by constructing effective liner systems; and (iii) minimizing the formation of leachate by preventing the addition of liquids during the active life of the landfill and constructing a low-permeability cover after filling is completed to prevent the formation of leachate. The Industry Standard does not include treating waste to minimize its long-term potential to impact groundwater quality. Under the proposed project, waste would be treated in place to minimize its potential for impacting groundwater quality without adversely impacting the other environmental protection features of the facility.

Improvement in Environmental Conditions that are Priorities to Stakeholders. Based on discussions between the applicant, the VADEQ, and the host communities for the Maplewood Landfill and the King George County Landfill groundwater-related issues that are priorities to stakeholders include (among others) minimizing the long-term threat to groundwater quality. This project provides a substantial improvement to the performance of the existing facilities by treating the waste in the landfills and, thereby, minimizing the potential for waste to present a long-term threat to groundwater quality. Routine groundwater monitoring is, and will continue to be, performed to verify containment.

- *Community Concerns.* Based on discussions between the applicant, the VADEQ, and the host communities for the Maplewood Recycling and Landfill and the King George County Landfill, community concerns related to groundwater quality are the same as those identified in the previous bullet and are addressed through long-term treatment of waste in place using the bioreactor process.

3.1.2.3 Potential Impact to Surface Water

The proposed project will provide environmental performance that is superior in respect to the baseline of potential impacts to surface water defined in Section 3.1.1.3 in several aspects. The five criteria used to evaluate superior performance in protecting surface-water quality are identified below, and the manner in which superior environmental performance will be measured is described in Section 3.1.3.

Improvements to Tier 1 Benchmarks. The Tier 1 benchmark for potential environmental impact to surface water is minimizing the occurrence of seeps and, as shown in Section 3.1.1.3, the proposed project is equivalent in this regard. In addition, less leachate would be routed from the facility to the publicly owned treatment works (POTW), where as much as five percent of pollutants in the leachate (i.e., wastewater) are typically released to surface-water bodies. Reducing the quantity of liquid sent from the facility to the POTW will correspondingly decrease the pollutant load to streams caused by discharges of residue from wastewater treatment plants. Further, surface water used in the bioreactor would reduce the quantity of stormwater routed off site, which would reduce off-site erosion and sedimentation impacts. In these manners, the project represents an improvement to the Tier 1 benchmarks presented in Section 3.1.1.3.

- *Pollution Prevention or Source Reduction.* By using leachate to treat waste in the landfill, the source of contamination (i.e., the incidental contaminants that are present in a landfill) is reduced and pollution is prevented. This results in superior environmental performance for protection of surface-water resources by eliminating the source of seeps and groundwater contamination, which can result in surface-water contamination in locations where groundwater discharges to surface water.

  Environmental Performance More Protective than the Industry Standard. The Industry Standard for surface-water protection is based on the use of standard stormwater management practices and mitigation of occasional seeps. In addition, by applying stormwater to waste, fewer adverse impacts to off-site receiving streams will be expected during the operating life of the landfill. Therefore, by applying leachate and stormwater, the environmental performance of the Maplewood and King George County Landfills will exceed the Industry Standard for surface-water protection.

  Improvement in Environmental Conditions that are Priorities to Stakeholders. Based on discussions between the applicant, the VADEQ, and the host communities for the Maplewood Landfill and the King George County Landfill, surface-water related issues that are priorities to stakeholders include (among others) protecting surface-water resources from impacts by leachate. This project addresses this concern by providing monitoring and operational procedures for preventing impact to surface-water resources by seeps.

  Community Concerns. Based on discussions between the applicant, the VADEQ, and the host communities for the Maplewood Landfill and the King George County Landfill, community concerns related to surface-water quality include the items identified in the immediately preceding bullet and are satisfied through compliance with existing permit conditions.

3. .2.4 Potential Environmental Impact to Air

The proposed project will provide environmental performance that is superior to the baseline of potential environmental impact to air defined in Section 3.1.1.4 in several aspects.

Should break out discussion of 2 landfills

Improvements to Tier 1 Benchmarks. The Tier 1 benchmark for potential environmental impact to air is to control landfill gas in a manner consistent with the requirements of state and Federal air quality permits. As described in Section 3.1.1.4, the proposed project meets this standard by providing landfill gas collection and control during the operating, closure, and post-closure periods. The existing Air System Quality Permit will be used as the criteria for determining if the gas collection and control needs modification. Under this project, landfill gas will likely be generated at a higher rate in the area where additional liquid is input as compared to other areas. This will increase the gas generation rate and may require additional active gas collection components, such as wells and header piping in those affected areas. As more gas is produced and collection structures are added, the collection efficiency will be improved. Therefore, under this project, less gas will be released from the landfill surface to the atmosphere than if the project were not implemented. In addition, the Tier 1 benchmark will be improved because there will be less impacts from leachate hauling trucks. Leachate is currently being transported from the landfills via truck to wastewater treatment plants. These trucks consume fuel, and there are vehicle emissions associated with this fuel consumption. If leachate is discharged (i.e., recirculated) into the waste, it will either be pumped using closed piping systems or hauled, using trucks, to the various discharge points on the landfill. By using leachate in the bioreactor, fuel consumption and vehicle emissions will be drastically reduced or eliminated as compared to a project performed outside of XL where leachate would be hauled off site. Emissions from on-site trucks (if they are used) will be reduced because haul distances to the treatment facilities are typically more than 50 miles as compared to on-site hauling distances of about 2 to 3 miles. Thus, a substantial long-term improvement in environmental performance for the proposed project will be recognized as compared to a facility operated outside of an XL project.

Pollution Prevention or Source Reduction. The practice of collecting and treating landfill gas throughout the operating period will result in a significant decrease in uncontrolled discharge of landfill gas and, therefore, represents a substantial improvement in the level of pollution prevention provided by the facilities. Fugitive emissions will be reduced because gas collection and control systems will be instituted earlier than if the facilities were operated outside the XL Program. (only in King George)

Environmental Performance More Protective than the Industry Standard. The Industry Standard for landfill gas management in Virginia involves providing active collection and control of landfill gas at landfills that have the potential to generate more than 50 Mg per year of NMOCs. As described in the first item above, the proposed project will exceed this standard because more landfill gas would be generated and collected during the time when active gas collection controls are required, resulting in more gas collected in a shorter period of time under the XL Program than outside the XL Program. The waste mass will more quickly be exhausted of its potential to generate gas, and more quickly approach a time when emissions are less the 50 Mg per year. Therefore, the environmental performance of the project will be more protective than the industry standard.

Improvement in Environmental Conditions that are Priorities to Stakeholders. Based on discussions between the applicant, the VADEQ, and the host communities for the Maplewood Landfill and the King George County Landfill, air-related issues that are priorities to stakeholders include (among others) preventing odor problems. This project provides a substantial improvement to the performance of the existing facilities by collecting landfill gas during the active period of filling. Therefore, even though the landfills may have higher gas generation rates under the XL Project than those sites outside of the XL Project, the proposed project represents an improvement on a key environmental condition of high priority to stakeholders.

Community Concerns. Based on discussions between the applicant, the VADEQ, and the host communities for the Maplewood Landfill and the King George County Landfill, community concerns related to air emissions or air quality include those identified above and are addressed through existing permit conditions and bioreactor design, construction, and operational methods.

3.1.3 How Environmental Performance Will Be Measured

Environmental performance will be measured throughout the project to demonstrate the environmental benefits described in Sections 3.1.1 and 3.1.2. In particular, measurements will be made of eight elements of the project as identified on Table 6 as well as the manner in which they will be measured. Most of the eight elements are dependent on the same variables, including rate of biological activity and avoidance of potential operational problems that could cause an impact to the environment. The measurements identified on Table 6 will be used to make a determination of superior environmental performance compared to non-recirculating and non-bioreactor landfills as follows.

Reduced Impacts to Groundwater Quality. If leachate quality improves over a period of several years or if a trend of improving leachate quality is evident after the initial 2- to 3-year period, then it will be concluded that improved leachate quality represents a reduced impact to the liner and leachate collection system and long-term groundwater quality.

Define baseline for # of / seeps to be considered significant

Reduced Impacts to Surface-Water Quality. If no significant increase in the occurrence of seeps occurs during the project compared to the occurrence of seeps at non-bioreactor landfills, then it will be concluded that the liquid application methods are acceptable and there are no potential adverse impacts to surface-water quality.

Reduced Impacts to Air Quality. Potential impacts to air quality will be reduced if: (i) waste degradation rates increase significantly, as determined by surveys before and after recirculation or bioreactor activities occur; (ii) the landfill gas management system is routinely monitored, maintained, and operated throughout the period of the project; and (iii) no significant odors occur or surface emissions are detected during the project. The improvements associated with not having to haul leachate will be recognized immediately. Environmental performance will be monitored as described in Sections 2.2.1.5 and 2.2.2.5, and the results of the monitoring will be presented semiannually to WM. A preliminary outline of a typical semi-annual report of monitoring is presented on Table 7.

3.2 Other Potential Benefits

The proposed XL Project is expected to result in several additional benefits. These benefits all result from the accelerated biological degradation that occurs at recirculating and bioreactor landfills. The benefits are identified below, along with an indication of the nature of the benefit.

Decreased Leachate Management Costs

Because leachate quality is better at recirculating and bioreactor landfills than at non-recirculating or non-bioreactor landfills, the total amount of leachate needs to be treated is reduced because some of the leachate is consumed in the biological reactions in the landfill. Also,,for landfill where leachate is recirculated less costly treatment techniques will be used in the long term if leachate eventually has to be taken off site for treatment and disposal. Therefore, recirculating and bioreactor landfills require less cost to manage leachate than non-recirculating or non-bioreactor landfills.

Increased Waste Disposal Capacity

The increased rate of biodegradation at recirculating and bioreactor landfills results in substantial settlement of waste during the landfills active life. In contrast, at non-recirculating or non-bioreactor landfills, most waste settlement occurs during post-closure (after the final cover has been placed over the waste), making it difficult and impractical to reclaim the disposal capacity gained through settlement. At recirculating and bioreactor landfills, a significant amount of settlement can occur during the active life of the landfill, making it possible to reclaim the disposal capacity gained due to settlement. Also, the waste mass becomes more stable sooner and better suited for end-use during post-closure. A substantial benefit of increased waste disposal capacity is the ability to delay or avoid siting a new waste disposal facility, a benefit that has a large quantitative economic benefit and a high qualitative benefit. Further, with additional disposal capacity, the host communities will receive additional revenue from fees paid on a "per ton" basis.

Increased Use of Recycled Materials

The materials to be used as the drainage media in the liquid application structure will typically include coarse aggregate or other suitable recyclable materials such as tire shreds. Tire shreds are commonly generated as a result of the cleanup of old tire piles in the Commonwealth of Virginia. When a beneficial use of tires such as this is available, a portion of the processing cost from the cleanup of tirepiles is paid by the VADEQ because of the beneficial end use. The tire cleanup program is funded by a tax on the purchase of new tires.

Improved Economics of Energy Recovery Project Feasibility

Energy recovery from landfill gas is a project that involves collection of landfill gas and beneficial use such as generating of energy either by direct generation of electricity or by burning the gas as an alternative energy source. The economic feasibility of such energy recovery projects is a function of the reliability of the quantity of landfill gas that can be generated during the life of the project. For example, landfills that generate a relatively small quantity of gas per year may not be candidates for an energy recovery project due to an insufficient quantity to make the project cost-effective. Even if the total quantity of landfill gas generated over the life of the facility is very large, certain projects may not be economical if the gas generation rate is relatively low. Because increased levels of biodegradation cause higher gas generation rates (such as in recirculating and bioreactor landfills) more gas is available in the short-term for energy recovery projects. With the increased rate of landfill gas being generated, energy recovery projects will be more economically feasible.

Earlier Availability for Re-Use of Site

Less settlement occurs during the post-closure period at recirculating and bioreactor landfills. This is because more of the potential settlement is achieved prior to closure. These landfills represent a reduced potential impact to environmental quality as described above in this application. Thus, there are more potential options for using the site during and after the post-closure period.

Reduced Settlement and Strain on Final Cover System

There is less potential for damage to the final cover system by settlement because more of the potential settlement occurs in recirculating and bioreactor landfills before the final cover system is constructed. This has a direct impact on the cost of the post-closure operation and maintenance activities. Because the final cover system will experience less settlement, the long-term containment of the final cover system is improved.

Decreased Post-Closure Care Costs

Because waste is stabilized more quickly in recirculating and bioreactor landfills, several long-term benefits occur as described in this section, including: (i) shorter time that leachate will need to be managed and, therefore, shorter period of leachate management system operation and leachate treatment; (ii) shorter duration of landfill gas generation and, therefore, shorter period of landfill gas management system operation; reduced settlement during the post-closure period and, therefore, decreased maintenance costs for repairing potential cover damage due to settlement; and (iii) decreased potential for groundwater degradation and, therefore, lower potential for the need for groundwater remediation. These benefits all result in lower post-closure care costs for recirculation or bioreactor landfills as compared to non-recirculating and non-bioreactor landfills. Based on studies performed by Shaw and Knight [2000], the estimated savings in post-closure operation and maintenance costs for bioreactor landfills is in the range of 40 to 60 percent as compared to non-bioreactor landfills.

Comparison Between Approaches to Bioreactor Technology

A significant technological benefit of this project is that it would allow for a direct comparison between the performance of bioreactor landfills operated with varying amounts of liquid introduced into the waste mass. This comparison can be made within the site itself from areas with and without liquid injection, and between the two sites. As previously described, the Maplewood Landfill would receive up to 4,000,000 gallons per year of liquid in a nominal 10-acre area. The King George County Landfill would receive as much as 8,000,000 gallons per year of liquid in approximately the same area. Because the landfills are located in the same area of the country, receive similar amounts of precipitation, and receive similar waste streams, the relative impact of liquid quantity on waste decomposition can be evaluated by comparing the results from the two.

3.3 Stakeholder Involvement

3.3.1 General Information

Primary participants include the regulatory community of USEPA and VADEQ, and WM, local community councils and government officials, and interested members of the public. USEPA and VADEQ have had considerable influence on the details of the project proposal and will continue their active involvement during the implementation phase.

Interested parties have demonstrated some interests in the project, yet do not wish to actively participate in project development and implementation. Interested parties will usually want be kept informed of project development and progress, and may wish to attend public meetings and contribute their comments in written or verbal form.

Members of the general public will, most likely, not become actively involved in project development and implementation. Although not actively involved, members will be provided with project information through the local media and central information repository. Members of the general public have the opportunity to participate more actively if they choose to do so.

A *Final Project Agreement* (FPA) is an agreement between the USEPA and the Sponsors stating the purpose and requirements of the project and how the project is to be implemented and evaluated. It is completed through a cooperative effort between the USEPA, Sponsors, and the Stakeholders.

A *permit amendment* amends an existing permit for a landfill. There are specific regulatory and technical requirements that must be met for a successful permit amendment. There are prescriptive public participation requirements. A landfill is typically permitted under 9 VAC 20-80-250 and 9 VAC 20-80-500 of the Virginia Solid

Waste Management Regulations (VSWMR) and by the Code of Virginia, §10.1-1400 *et seq*. However, because the bioreactor projects are not typical at landfills the permits will be amended under VSWMR, 9 VAC 20-80-480.G which allows for an experimental permit for innovative treatment technologies.

3.3.2 First Contact and Subsequent Meetings

Public Meeting on 1 August 2000 (King George County) and 2 August 2000 (Amelia County) to solicit comments from the public on the intent of the Sponsors to participate in Project XL

Public Meetings the week of 14 August 2000 to discuss the draft FPA with the citizens.

Public Meeting and Hearing 16 October 2000 (King George County) and 17 October 2000 (Amelia County) to discuss the Draft Permit Amendments for the landfills.

A kickoff meeting scheduled for 1 August 2000 for King George County and 2 August 2000 for Amelia County will be announced in the local papers the week of 17 July 2000. Both meetings will be held at 7:00 p.m. A copy of the advertisements are provided in Appendix VI and include project information, contact information, and repository information. The public will have about 10 to 15 days to respond with comments after the public meeting is held. Participants may become actively involved at the time of the meetings in the continuing process or be put on a mailing list to receive periodic information. Another public meeting may be held a few weeks later to solicit additional participants and comments. As part of the VADEQ's permitting process, a public hearing must be held on each of the draft permit amendments. Details of the public hearing process are provided below. It is anticipated that the public hearings for each of the draft permits will most likely occur the week of 16 October 2000. At the second meetings, the Draft FPA will be made available for review and comment. As the FPA is revised and amended, it will be made available at subsequent meetings and at the local library. The availability of the FPA will be advertised prior to the public hearings held by the VADEQ.

3.3.3 County Endorsement

The Counties of Amelia and King George endorse the respective projects as evidence by letters of support. These landfills have not had major opposition but, rather, had public support. Conditions of the host agreements provide benefits to the residences of both counties through revenue and jobs. The respective projects under Project XL would not affect the host agreements, thus the Counties would continue to receive these benefits. Thus, any Stakeholder opposition in these counties is anticipated to be minimal. However, the sponsors will publish an advertisement describing the desired projects as discussed above. An additional advertisement will be part of the VADEQ's public participation process as outlined below.

3.3.4 State Public Participation Requirements

Before VADEQ issues a permit amendment, it holds a public hearing in the locality to solicit comments on the draft permit from concerned citizens. The public hearing is advertised in the local paper. The public hearing is held a minimum of 30 days from the date of the advertisement. Public comment period begins the day of advertisement and ends 15 days after the public hearing is held. Furthermore, the VADEQ has a standardized mailing list of state agencies to whom a draft permit or notice of draft permit is sent to solicit comments. The VADEQ evaluates the comments and prepares a public response document. The VADEQ Director then decides within 30 days after the close of comment period whether or not to issue the permit. Conditions may be imposed due to additional state requirements or as a result of public comment. In the initial stages of permitting, the applicant notifies all of the adjacent property owners of his intent to modify or expand the landfill. In this notification, the project is described and contact information is provided. The citizens can comment on the project at this stage or at any other stage of the permitting process until the permit has been issued.

Since both landfills have a valid permit, the VADEQ intends to amend the permit to allow the bioreactor systems as an experimental process. The major amendments would be advertised and open to comment as described above. The details of the respective projects would be outlined in the advertisements along with contact information and document viewing locations. It is anticipated this would help identify additional Stakeholders.

3.3.5 Expert Technical Reviewers and Commenters

There will be specific experts and technical advisors who will review the FPA and make appropriate comments on its technical adequacy and regulatory compliance. Some of these Stakeholders have already been contacted by the Sponsors and have agreed, in part, to review the project. They include faculty members from Virginia Polytechnic Institute and State University (Virginia Tech) and North Carolina State University. Specific individuals are not named in this report because, depending upon availability, they may change over the course of the review time. Other third-party expert reviewers may include Waste Policy Institute, EMCON, and Richardsons and Associates. They will be contacted and offered the opportunity to review and comment.

3.3.6 Getting the Word Out

The public hearings as required by the VADEQ will be supplemented with additional Stakeholder meetings, as necessary. A partial mailing list is attached. The mailing list would be updated as necessary to include private citizens and other interested parties. Periodically, progress reports and other relevant information will be distributed. Mail would be sent on a recurring date or as information is made available. If desired, the Sponsors will provide site tours and briefings to better educate the Stakeholders. Transcripts and video tape recordings of all public meetings and hearings will be maintained at the repositories.

3.3.7 Repository Information

An official record of the project will be maintained by the Sponsors at 629 East Main Street, Richmond, VA, 22129 c/o Paul Farrell, (804) 698-4214. A mirror set will be maintained within each county at the local library. The address for the library in Amelia County is: the James Hamner Memorial Library, 16351 Dunn Street Amelia, Virginia 23002 and the file will be entitled "Amelia County Landfill, Maplewood Site, Project XL". The address for the library in King George County is: L.F. Smoot Lewis Memorial Library, 9533 Kings Highway, King George, Virginia 22485, and the file will be entitled "King George County Landfill Project XL".

3.3.8 Stakeholder Meetings and FOIA

Once the Stakeholders have been clearly identified, the Sponsors will periodically meet with the representative of each group or the entire group to discuss issues of concern and to disseminate information. Other members of the groups may personally voice a concern or receive progress reports during the planned public meetings. All information is public domain. Any information that is not currently in the repository may be obtained through a "freedom of information act" (FOIA). To facilitate informational requests, all FOIA request will be placed on a fast-track. It must still meet all of the legal requirements of a FOIA but the information will be provided in a timely manner. The information requested will then be put in the repositories for future reference.

3.3.9 Nationwide Solicitation

To solicit additional Stakeholder involvement, the Sponsors will contact nationwide professional and citizen groups that may have an interest in bioreactor technology. The Solid Waste Association of North America has monthly publications to disseminate information to its members. Periodically, the Sponsors may attend national workshops or seminars. These meetings would be an ideal forum to present the merits of the individual projects and to actively recruit Stakeholders.

3.3.10 Stakeholders Shaping the Process

The initial meetings will solicit comments and provide information to the public in order for them to the make an informed opinion of the process. The Stakeholders may, at any time, provide to the Sponsors comments on the Proposal. However, in order to create an enforceable document, the comments must be incorporated into the final permit required by the VADEQ. During the VADEQ public participation process, the VADEQ responds to the comments through a public response document. Conditions may be imposed due to additional VADEQ requirements or as a result of public comment. The permit is an enforceable document under the Virginia Solid Waste Management Act. Public comments shape the final permit.

3.4 Innovation or Pollution Prevention

The proposed project provides a high level of innovation for managing leachate and environmental quality at a MSW landfill. Although not a new technology, leachate recirculation and other bioreactor technologies are not widely used at MSW landfills in the United States. The applicant believes that this is due, in part, to a lack of data that demonstrates the benefits of the technologies and information on how to best apply these technologies. Current state and Federal regulations also create some limitations where the proposed XL project, described in this application, is intended to provide data to further demonstrate the benefits of leachate recirculation and other bioreactor technology.

In addition to being innovative, leachate recirculation and bioreactor technologies represent a significant advancement in reducing potential pollution from MSW landfills. The key pollution prevention aspects of these technologies are: (i) retention and treatment of leachate in the landfill, where it is well contained and can be processed utilized and treated in a secure environment; (ii) decreased impacts to air quality through the use of landfill gas collection system through the operating life of the facility in areas where biodegradation is being promoted; and (iii) increased rate of stabilization of waste, which results in improved leachate quality in the long term and a smaller potential for impacts to groundwater quality.

3.5 Transferability

The approaches described in this application have an outstanding degree of transferability. The technologies that will be demonstrated during this project can be used at most operating MSW landfills in the United States. Therefore, by applying the findings of this project and other leachate recirculation projects, owners and operators of MSW landfills across the United States can achieve improved, superior environmental performance in terms of groundwater protection, surface-water protection, and air protection. In addition, substantial cost-saving benefits can be realized resulting from increased disposal capacity, decreased leachate management costs, and decreased post-closure costs.

3.6 Feasibility

Leachate recirculation and bioreactor technologies have been used at several other waste disposal facilities, as presented on Table 2. Based on the successful applications of these technologies and operational experience at other facilities, the proposed project is feasible.

3.7 Evaluation, Monitoring, and Accountability

3.7.1 Accountability

The two landfills involved in this demonstration project operate under their respective Commonwealth of Virginia solid waste and air quality permits. Each permit is an enforceable document that carries civil penalties for major violations. The Director of the VADEQ has the authority to revoke the permit if necessary. However, there have been no Notices of Violation at either site.

WM is willing to provide accountability of site environmental compliance through a voluntary commitment to achieve the project goals defined in Section 3.1.1. In general, the voluntary commitment that WM offers is to maintain or exceed the level of environmental protection provided by the current design and permit for the facility. In the event that the terms of the FPA are not satisfied, then WM will discontinue the bioreactor programs at the subject landfills. The terms of the FPA may be incorporated into the amended Commonwealth of Virginia permits as conditions in order to provide an enforceable document. Failure to achieve the stipulated goals would be referred to the respective WM Regional Compliance and Enforcement Staff for review and action.

3.7.2 Tracking, Reporting, and Evaluation

Data collection, evaluation, and reporting requirements are identified in Section 2. In general, for each facility, the data collection and analysis requirements of the XL Program features will be reported semiannually to the VADEQ as described in Section 3.1.3 or as otherwise required by VADEQ.

3.7.3 Failure to Meet Expected Performance Levels

In the event that the expected levels of performance are not achieved, then the bioreactor programs will be reviewed with the WM and the operation of the facilities will be modified to attempt to better achieve expected goals.

3.8 Shifting Risk of Burden

WM does not propose to shift the burden of any of the risks associated with operating the landfills as a result of this project. In particular, any risk of failure of the proposed leachate recirculation or bioreactor systems will be borne by WM. The risks that could be shifted include: (i) impacts to media; (ii) impacts to disadvantaged communities; and (iii) financial burden of post-closure care or operation. The proposed project does not represent a shift of risk burden because: (i) the technologies involved do not transfer pollutants from one environmental media to another; (ii) there are no disadvantaged communities near the two sites; and (iii) WM will continue to assume the financial burden of all operations, and monitoring and post-closure care for the facilities. In fact, the proposed project results in decreased overall risk associated with waste management because, in the long term, the accelerated biodegradation provided by the project results in a reduced risk of potential impacts from releases of leachate or landfill gas to the environment.

4. DESCRIPTION OF THE REQUESTED FLEXIBILITY AND IMPLEMENTING MECHANISMS

4.1 Requested Flexibility

As part of the proposal, WM is requesting that the USEPA grant regulatory flexibility from the requirement of the RCRA that prohibits application of bulk liquids in MSW landfills, as presented in 40 CFR 258.28. This specific regulation deals with the application of liquids in the following manner:

- it restricts recirculation of leachate to landfills that have a liner system that has a 60-mil thick geomembrane overlying a 2-ft thick layer of clay having a hydraulic conductivity no greater than $1x10^{-7}$ cm/sec; and

- it prohibits the placement of liquid wastes other than leachate in any MSW landfill.

As described in Section 2, liquids are needed to enhance the biological degradation of waste in the landfills. Therefore, WM proposes to add liquids to both landfills and to add certain nonhazardous liquid wastes (e.g., leachate, stormwater, gray water, septic waste, etc.). The Maplewood Landfill currently has an active landfill gas collection system that is in operation; if odor problems or air quality problems occur, then the system will be expanded as needed (e.g., using additional extraction wells or trenches or by placing less permeable cover and affected areas). Further, both the Maplewood and King George County Landfills have liner systems that are superior in performance to the liner system described above. Because such addition of liquids is prohibited at landfills having the type of liner system that was constructed at the Maplewood and King George County Landfills, flexibility is needed from the requirements of 40 CFR 258.28 to proceed with the project.

4.2 Legally Implementing Mechanisms

To implement this Project, the parties intend to take the following steps:

EPA expects to propose for public comment and promulgate a site-specific rule amending 40 CFR 258.28 for the Maplewood and King George County Landfills. This site-specific rule will describe the project requirements and any other aspects of the rulemaking. It is expected that the site-specific rule will provide for Withdrawal or Termination and a Post-Project Compliance Period consistent with Section VII, and will address the Transfer procedures included in Section X. The standards and reporting requirements set forth in Section II (and any attachments to this FPA) will be implemented in this site-specific rulemaking.

The Commonwealth of Virginia under its relevant authority expects to modify any permits necessary to implement this FPA.

Except as provided in any rule(s), compliance order(s), permit provisions or other implementing mechanisms that may be adopted to implement the Project, the parties do not intend that this FPA will modify or otherwise alter the applicability of existing or future laws or regulations to the Maplewood or King George County Landfills.

By signing this FPA, USEPA, the Commonwealth of Virginia and its local authorities acknowledge and agree that they have the respective authorities and discretion to enter into this FPA and to implement the provisions of this project, to the extent appropriate.

4.3 Compliance and Enforcement History

VADEQ has the regulatory authorities over Maplewood and King George County Landfill. Staff at the VADEQ conduct air, waste, and wastewater inspections at the two facilities on a regular basis. The compliance and enforcement history of the facilities has been reviewed for this particular application.

King George County Landfill

Waste Inspection. Conducted monthly by the VADEQ's Northern Virginia Regional Office. The VADEQ has reviewed the most recent 12 monthly inspection reports. The overall rating for each inspection is satisfactory. No Notice of Violation has been issued.

- *Air Inspection.* In 1990, the USEPA established an Operating Permit Program under Title V (40 CFR Part 70) of the Federal Clean Air Act (CAA). Title V is an operating permit program, enforced through federal and state rules, requiring compilation of an air emissions inventory, identification of applicable regulations, and certifications of compliance. This facility has submitted a Title V permit application to the VADEQ and the approval is pending. However, the facility was issued a State Operating Permit and is inspected annually by the VADEQ's Fredericksburg Satellite Office. The applicable regulations include New Source Performance Standards (NSPS) and State Implementation Plan (SIP). The review on the recent annual inspection reports indicates that the facility is in good standing with the applicable regulations.

- *Stormwater Inspection.* The leachate generated in this facility is hauled to and treated in a public owned wastewater treatment facility. The facility is exempt from the requirements of the Virginia Pollutant Discharge Elimination System (VPDES) permit for its stormwater run-off control. Stormwater is monitored in accordance with an agreement between WM and King George County. The run-off stormwater is collected into sedimentation basins via conveyance channels before being discharged to natural waterways. Diversion channels were constructed to minimize stormwater run-on.

Maplewood Landfill

Waste Inspection. The waste inspection is conducted monthly by the VADEQ's Piedmont Regional Office. The VADEQ has reviewed the most recent 12 inspection reports. The overall rating for each inspection is satisfactory. No Notice of Violation has been issued.

Air Inspection. Same as King George County Landfill, the facility submitted a Title V permit application and the approval is pending. However, the facility holds a valid new Source Review (NSR) permit and the air inspection is conducted once a year by the VADEQ's Lynchburg Satellite Office. The inspection reports for the past three years have been reviewed by the VADEQ. The results of the three reports indicate that the facility has been in compliance with the applicable regulations which include NSPS and SIP.

- *Stormwater Inspection.* Currently, leachate generated from this facility is collected and temporarily stored in the storage tanks on site. The leachate is then hauled to a treatment facility for further treatment. Direct discharge of leachate to surface water is prohibited in this facility. The facility has a VPDES permit for its stormwater run-off control. Perimeter diversion and collection channels are constructed for run-off and run-off storm water control respectively. The run-off stormwater enters to sedimentation basins before being discharged to surface waterway.

5. DISCUSSION OF INTENTIONS AND COMMITMENTS FOR IMPLEMENTING THE PROJECT

5.1 Intentions and Commitments

WM would like to operate the areas identified in Section 1 as controlled bioreactor landfills to attain a number of superior environmental and cost savings benefits. The county is committed to working with federal, state, and local governments to demonstrate, with regulatory flexibility, how a bioreactor landfill can attain more desirable environmental results than a conventional landfill.

5.2 WM's and the Commonwealth of Virginia's Intentions and Commitments

WM intends to propose and have issued (subject to applicable procedures and review of public comments) a site-specific rule, amending 40 CFR Part 258.28, that applies specifically to the WM Maplewood and King George County Landfills. The site-specific rule will also provide for withdrawal or termination and a post-Project compliance period consistent with Section XII of this Agreement, and will address the transfer procedures included in Section IX. The standards and reporting requirements set forth in Section 5.5 will be implemented in the site specific rule.

5.3 Project XL Performance Targets

See Table 6, Superior Environmental Performance.

5.4 Proposed Schedule and Milestones

This project will be developed and implemented over a time period necessary to complete its desired major objectives, beginning from the date that the final legal mechanism becomes effective, unless it is terminated earlier or extended by agreement of all Project Signatories. An expected timeline is shown on Figure 6.

5.5 Project Tracking, Reporting and Evaluation

The project tracking, reporting and evaluation will be accomplished for project sponsors including WM in accordance with, among other things, WM requests and the reporting requirements set forth by this FPA and other requirements set forth by VADEQ. The topics tracked, reported and evaluated have been referred to above in Section 5.4 and summarized in Figure 6.

5.6 Periodic Review by the Parties to the Agreement

The Parties will hold periodic performance review conferences to assess their progress in implementing this Project. Unless they agree otherwise, the date for those conferences will be concurrent with annual Stakeholder Meetings. No later than 30 days following a periodic performance review conference, WM will provide a summary of the minutes of that conference to all Direct Stakeholders. Any other comments of participating Stakeholders will be reported to WM.

5.7 Duration

This Agreement will remain in effect for 5 years after signing, unless the Project ends at an earlier date, as provided under Section 8 (Amendments or Modifications); Section 11 (Withdrawal or Termination), or Section 9 (Transfer of Project Benefits and Responsibilities). The implementing mechanism(s) will contain "sunset" provisions ending authorization for this Project 4 years after the effective date of the implementing mechanism(s). They will also address withdrawal or termination conditions and procedures (as described in Section 11). This Project will not extend past the agreed upon date, and WM will comply with all applicable requirements following this date (as described in Section 12), unless all parties agree to an amendment to the Project term (as provided in Section 8).

6. LEGAL BASIS FOR THE PROJECT

6.1 Authority to Enter Into the Agreement

By signing this Agreement, all signatories acknowledge and agree that they have the respective authorities, discretion, and resources to enter into this Agreement and to implement all applicable provisions of this Project, as described in this Agreement.

6.2 Legal Effect of the Agreement

This Agreement states the intentions of the Parties with respect to WM's XL Project. The Parties have stated their intentions seriously and in good faith, and expect to carry out their stated intentions. This Agreement in itself does not create or modify legal rights or obligations, is not a contract or a regulatory action, such as a permit or a rule, and is not legally binding or enforceable against any Party. Rather, it expresses the plans and intentions of the Parties without making those plans and intentions binding requirements. This applies to the provisions of this Agreement that concern procedural as well as substantive matters. Thus, for example, the Agreement establishes procedures that the parties intend to follow with respect to dispute resolution and termination (see Sections 10 and 11). However, while the parties fully intend to adhere to these procedures, they are not legally obligated to do so.

WM intends to propose for public comment a site specific rule making needed to implement this Project. Any rules, permit modifications or legal mechanisms that implement this Project will be effective and enforceable as provided under applicable law..

This Agreement is not a "final agency action" by WM, because it does not create or modify legal rights or obligations and is not legally enforceable. This Agreement itself is not subject to judicial review or enforcement. Nothing any Party does or does not do that deviates from a provision of this Agreement, or that is alleged to deviate from a provision of this Agreement, can serve as the sole basis for any claim for damages, compensation or other relief against any Party.

6.3 Other Laws or Regulations That May Apply

Except as provided in the legal implementing mechanisms for this Project, the parties do not intend that this FAP will modify any other existing or future laws or regulations.

6.4 Retention of Rights to Other Legal Remedies

Except as expressly provided in the legal implementing mechanisms described in Section IV, nothing in this Agreement affects or limits, WM's, the VADEQ's, or any other signatory's legal rights. These rights include legal, equitable, civil, criminal or administrative claims or other relief regarding the enforcement of present or future applicable federal and state laws, rules, regulations or permits with respect to the facility.

Although WM does not intend to challenge agency actions implementing the Project (including any rule amendments or adoptions, permit actions, or other action) that are consistent with this Agreement, WM reserves any right it may have to appeal or otherwise challenge any USEPA, Commonwealth of Virginia, or local agency action to implement the Project. With regard to the legal implementing mechanisms, nothing in this Agreement is intended to limit WM's right of to administrative or judicial appeal or review of those legal mechanisms, in accordance with the applicable procedures for such review.

7. UNAVOIDABLE DELAY DURING PROJECT IMPLEMENTATION

"Unavoidable delay" (for purposes of this Agreement) means any event beyond the control of any Party that causes delays or prevents the implementation of the Project described in this Agreement, despite the Parties' best efforts to put their intentions into effect. An unavoidable delay can be caused by, for example, a fire or acts of war.

When any event occurs that may delay or prevent the implementation of this Project, whether or not it is avoidable, the Party to this Agreement who knows about it will immediately provide notice to the remaining Parties. Within ten days after that initial notice, the Party should confirm the event in writing. The confirming notice should include: (i) the reason for the delay; (ii) the anticipated duration; (iii) all actions taken to prevent or minimize the delay; and (iv) why the delay was considered unavoidable, accompanied by appropriate documentation.

If the Parties, agree that the delay is unavoidable, then relevant parts of the project schedule (see Section 5) will be extended to cover the time period lost due to the delay. If they agree, they will also document their agreement in a written amendment to this Agreement. If the Parties don't agree, then they will follow the provisions for Dispute Resolution outlined below.

This section applies only to provisions of this Agreement that are not implemented by legal implementing mechanisms. Legal mechanisms, such as permit provisions or rules, will be subject to modification or enforcement as provided under applicable law.

8. AMENDMENTS OR MODIFICATIONS TO THE AGREEMENT

8.1 General Requirements

This Project is an experiment designed to test new approaches to environmental protection and there is a degree of uncertainty regarding the environmental benefits and costs associated with activities to be undertaken in this Project. Therefore, it may be appropriate to amend this Agreement at some point during its duration.

This FPA may be amended by mutual agreement of all parties at any time during the duration of the Project. The parties recognize that amendments to this Agreement may also necessitate modification of legal implementation mechanisms or may require development of new implementation mechanisms. If the Agreement is amended, WM and USEPA expect to work together with other regulatory bodies and stakeholders to identify and pursue any necessary modifications or additions to the implementation mechanisms in accordance with applicable procedures (including public notice and comment). If the parties agree to make a substantial amendment to this Agreement, the general public will receive notice of the amendment and be given an opportunity to participate in the process, as appropriate.

The parties to this FPA agree to evaluate the appropriateness of a modification or "reopener" to the FPA according to the provisions set forth below.

1. During the minimum project term, WM may seek to reopen and modify this FPA in order to address matters covered in the FPA, including failure of the project to achieve superior environmental results, or the enactment or promulgation of any environmental, health, or safety law or regulation after execution of this FPA which renders the project legally, technically, or economically impractical. To do so, WM will submit a proposal for a reopener under this section to USEPA, WM, and all applicable local agencies for their consideration. USEPA, and all applicable local agencies will review and evaluate the appropriateness or such proposal submitted by WM. USEPA, WM, and all applicable local agencies may also elect to initiate withdrawal or termination under Section 7 of this FPA, which shall supersede application to this section.

2. In determining whether to reopen and modify the FPA in accordance with any reopener proposal(s) submitted by WM under this section, USEPA, WM, and all applicable local agencies will base their decision upon the following: (a) whether the proposal meets Project XL criteria in effect at the time of the proposal; (b) the environmental benefits expected to be achieved by the proposal; (c) the level of emissions or effluent included in the proposal; (d) other environmental benefits achieved as a result of other activities under the proposal; and (e) and adverse environmental impacts expected to occur as a result of the proposal.

3. All parties to the FPA will meet within 90 days following submission of any reopener proposal by WM to USEPA, the VADEQ, and all applicable local agencies (or within such shorter or longer period as the parties may agree) to discuss the Agencies' evaluation of the reopener proposal. If, after appropriate stakeholder involvement, the Agencies support reopening of this FPA to incorporate the proposal, the parties (subject to any required public comment) will take steps necessary to amend the FPA. Concurrent with amendment of this FPA, USEPA, WM, and all applicable local agencies will take steps consistent with this Section IV to implement the proposal.

4. It is noted at this point that the intent by WM, upon successful results, to operate the ensuing landfill module as a bioreactor could be a "reopener". If this is agreeable to all parties to the present agreement, it would be most convenient to extend the agreement to cover subsequent module or modules at the Landfills, with a minimum of stakeholder work.

8.2 State Requirements

In accordance with 9 VAC 20-80-480.G, *"The director may issue an experimental facility permit for any solid waste treatment facility which proposes to utilize an innovative and experimental solid waste treatment technology or process..."*, Maplewood and King George County Landfill, will submit permit amendment applications to obtain experimental permits for the proposed bioreactor landfill areas. Specific criteria will be developed by the Office of Waste Permitting at VADEQ to guide the design, operation, and construction of bioreactor landfills. The staff in the office will review the experimental permit application from different aspects including local certification, design, construction, operation, closure, variance, finance assurance, and public participation.

In the current permits, both facilities hold a variance to a 9 VAC 20-80-250.B.9 that is the composite liner as required by RCRA Subtitle D and VSWMR. Under the current federal and state regulations, the facilities must file variance petitions for recirculating leachate within landfills underlain by alternate liner systems. In addition, King George County Landfill must submit an additional variance petition for introducing bulk liquids into the proposed bioreactor landfill area.

If the permit applications are found to be administratively complete and technically acceptable, draft permits will be developed by the VADEQ. The permit issuance procedure will follow 9 VAC 20-80-500.E, in which a public notice of the draft permit shall be made and a public hearing shall be held subsequently. The VADEQ director will make a final decision to the permit, to deny a permit or to amend the draft permit within 30 days of the close of the hearing comment period.

In accordance with 9 VAC 20-80-480.G, an experimental permit shall provide for operation of the facility for no longer than one calendar year unless renewed as provided in 9 VAC 20-80-480.G.3 which stipulates that the permit may be renewed no more than three times with each renewal for a period of not more than one calendar year.

At this point, amendments on air or stormwater permits are not anticipated for either facilities. However, the VADEQ Office of Waste Permitting will work with other permitting groups if any amendments on air or stormwater become necessary.

9. TRANSFER OF PROJECT BENEFITS AND RESPONSIBILITIES TO A NEW OWNER

The parties expect that the implementing mechanisms will allow for a transfer of WM's benefits and responsibilities under the Project to any future owner or operator upon request of WM and the new owner or operator, provided that the following conditions are met:

A. WM will provide written notice of any such proposed transfer to the WM, the Commonwealth of Virginia, and all applicable local agencies at least 90 days before the effective date of the transfer. The notice is expected to include identification of the proposed new owner or operator, a description of its financial and technical capability to assume the obligations associated with the Project, and a statement of the new owner or operator's intention to take over the responsibilities in the XL Project of the existing owner or operator.

B. Within 45 days of receipt of the written notice, the parties expect that WM, the Commonwealth of Virginia, and all applicable local agencies in consultation with all stakeholders, will determine whether: (i) the new owner or operator has demonstrated adequate capability to meet WM's requirements for carrying out the XL Project; (ii) is willing to take over the responsibilities in the XL Project of the existing owner or operator; and (iii) is otherwise an appropriate Project XL partner. Other relevant factors, including the new owner or operator's record of compliance with Federal, state and local environmental requirements, may be considered as well. It is expected that the implementation mechanism will provide that, so long as the demonstration has been made to the satisfaction and unreviewable discretion of WM, the Commonwealth of Virginia, and all applicable local agencies and upon consideration of other relevant factors, the FPA will be modified to allow the proposed transferee to assume the rights and obligations of WM. In the event that the transfer is disapproved by any agency, withdrawal or termination may be initiated, as provided in Section 11.

It will be necessary to modify the Agreement to reflect the new owner and it may also be necessary for WM, the Commonwealth of Virginia, and all applicable local agencies to amend appropriate rules, permits, or other implementing mechanisms (subject to applicable public notice and comment) to transfer the legal rights and obligations of WM under this Project to the proposed new owner or operator. The rights and obligations of this project remain with WM prior to their final, legal transfer to the proposed transferee.

10. PROCESS FOR RESOLVING DISPUTES

Any dispute which arises under or with respect to this Agreement will be subject to informal negotiations between the parties to the Agreement. The period of informal negotiations will not exceed 20 calendar days from the time the dispute is first documented, unless that period is extended by a written agreement of the parties to the dispute. The dispute will be considered documented when one party sends a written Notice of Dispute to the other parties.

If the parties cannot resolve a dispute through informal negotiations, the parties may invoke non-binding mediation by describing the dispute with a proposal for resolution in a letter to the Regional Administrator for USEPA Region 3, with a copy to all parties. The Regional Administrator will serve as the non-binding mediator and may request an informal mediation meeting to attempt to resolve the dispute. He or she will then issue a written opinion that will be non-binding and does not constitute a final WM action. If this effort is not successful, the parties still have the option to terminate or withdraw from the Agreement, as set forth in Section 11 below.

11. WITHDRAWAL FROM OR TERMINATION OF THE AGREEMENT

11.1 Expectations

Although this Agreement is not legally binding and any party may withdraw from the Agreement at any time, it is the desire of the parties that it should remain in effect through the expected duration of 5 years, and be implemented as fully as possible unless one of the conditions below occur:

Failure by any party to: (i) comply with the provisions of the enforceable implementing mechanisms for this Project; or (ii) act in accordance with the provisions of this Agreement. The assessment of the failure will take its nature and duration into account.

2. Failure of any party to disclose material facts during development of the Agreement.

3. Failure of the Project to provide superior environmental performance consistent with the provisions of this Agreement.

4. Enactment or promulgation of any environmental, health or safety law or regulation after execution of the Agreement, which renders the Project legally, technically or economically impracticable.

5. Decision by an agency to reject the transfer of the Project to a new owner or operator of the facility.

In addition, WM, the USEPA, and all applicable local agencies do not intend to withdraw from the Agreement if WM does not act in accordance with this Agreement or its implementation mechanisms, unless the actions constitute a substantial failure to act consistently with intentions expressed in this Agreement and its implementing mechanisms. The decision to withdraw will, of course, take the failure's nature and duration into account.

WM will be given notice and a reasonable opportunity to remedy any "substantial failure" before WM's withdrawal. If there is a disagreement between the parties over whether a "substantial failure" exists, the parties will use the dispute resolution mechanism identified in Section 10 of this Agreement. WM, the USEPA, and all applicable local agencies retain their discretion to use existing enforcement authorities, including withdrawal or termination of this Project, as appropriate. WM retains any existing rights or abilities to defend itself against any enforcement actions, in accordance with applicable procedures.

11.2 Procedures

The parties agree that the following procedures will be used to withdraw from or terminate the Project before expiration of the Project term. They also agree that the implementing mechanism(s) will provide for withdrawal or termination consistent with these procedures.

1. Any party that wants to terminate or withdraw from the Project is expected to provide written notice to the other parties at least sixty days before the withdrawal or termination.

2. If requested by any party during the sixty day period noted above, the dispute resolution proceedings described in this Agreement may be initiated to resolve any dispute relating to the intended withdrawal or termination. If, following any dispute resolution or informal discussion, a party still desires to withdraw or terminate, that party will provide written notice of final withdrawal or termination to the other parties.

3. If any agency withdraws or terminates its participation in the Agreement, the remaining agencies will consult with WM to determine whether the Agreement should be continued in a modified form, consistent with applicable federal or State law, or whether it should be terminated.

4. The procedures described in this section apply only to the decision to withdraw or terminate participation in this Agreement. Procedures to be used in modifying or rescinding any legal implementing mechanisms will be

governed by the terms of those legal mechanisms and applicable law. It may be necessary to invoke the implementing mechanism's provisions that end authorization for the Project (called "sunset provisions") in the event of withdrawal or termination.

12. COMPLIANCE AFTER THE PROJECT IS OVER

12.1 Introduction

The parties intend that there be an orderly return to compliance upon completion, withdrawal from, or termination of the Project, as follows:

12.2. Orderly Return to Compliance with Otherwise Applicable Regulations if the Project Term is Completed

If, after an evaluation, the Project is terminated because the term has ended, then WM will return to compliance with all applicable requirements by the end of the Project term, unless the Project is amended or modified in accordance with Section 8 of this Agreement (Amendments or Modifications). WM is expected to anticipate and plan for all activities to return to compliance sufficiently in advance of the end of the Project term. WM may request a meeting with the USEPA, and all applicable local agencies to discuss the timing and nature of any actions that they will be required to take. The parties should meet within thirty days of receipt of WM's written request for such a discussion. At and following such a meeting, the parties should discuss in reasonable, good faith, which of the requirements deferred under this Project will apply after termination of the Project.

12.3 Orderly Return to Compliance with Otherwise Applicable Regulations in the Event of Early Withdrawal or Termination

In the event of a withdrawal or termination not based on the end of the Project term and where WM has made efforts in good faith, the parties to the Agreement will determine an interim compliance period to provide sufficient time for WM to return to compliance with any regulations deferred under the Project. The interim compliance period will extend from the date on which WM, the Commonwealth of Virginia, and all applicable local agencies provides written notice of final withdrawal or termination of the Project, in accordance with Section 11 of this Project Agreement. By the end of the interim compliance period, WM will comply with the applicable deferred standards set forth in 40 CFR Part 258.28. During the interim compliance period, WM, the

Commonwealth of Virginia, and any applicable local agency may issue an order, permit, or other legally enforceable mechanism establishing a schedule for WM to return to compliance with otherwise applicable regulations as soon as practicable. This schedule cannot extend beyond six months from the date of withdrawal or termination. WM intends to be in compliance with all applicable Federal, State, and local requirements as soon as is practicable, as will be set forth in the new schedule.

13. SIGNATORIES AND EFFECTIVE DATE

[To Be Completed]

14. REFERENCES

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Vasuki, N.C., *Leachate Generation in a Lined Landfill: A Case Study of the Central Solid Waste Facility at Sandtown, DE,*" Purdue University Industrial Waste Conference Proceedings, 1986.

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TABLES

TABLE 1 - PROJECT XL CRITERIA: EVALUATION SUMMARY

CRITERION	DOES PROPOSED PROGRAM MEET REQUIREMENT?	LOCATION IN APPLICATION WHERE REQUIREMENT IS ADDRESSED
A. Superior Environmental Performance		
a. Tier 1: Project Equivalence	yes	3.1.1
b. Tier 2: Superior Environmental Performance	yes	3.1.2
c. Measurement of Environmental Performance	yes	3.1.3
B. Flexibility and Other Benefits	yes	3.2
C. Stakeholder Involvement	yes	3.3
D. Innovation in Pollution Prevention	yes	3.4
E. Transferability	yes	3.5
F. Feasibility	yes	3.6
G. Evaluation, Monitoring, and Accountability	yes	3.7
H. Shifting of Risk Burden	yes	3.8

Reference: USEPA [1999]

TABLE 2 - SUMMARY OF FIELD-SCALE LEACHATE RECIRCULATION AND BIOREACTOR PROJECTS

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Yorkshire, England Seamer-Carr Landfill [Robinson and Maris, 1985]	Field-Scale Study	• 6.2-acre cell used as leachate recycle area. • Approximate 6-acre control area. • Cell lined with 100-mil HDPE with leachate collection system. • 13 ft of pulverized refuse placed in cells. • Leachate redistributed by spray pipe networks laid on top of refuse. • Furrows later dug into surface to reduce ponding. • Recirculation and monitoring period approximately 3 years. • 36,000 gallons of leachate storage available.
Delaware Solid Waste Authority Central Solid Waste Management Center Sandtown, Delaware [Vasuki, 1986]	Field-Scale Study	• Leachate recycle in 2 full-scale landfill cells. • 9-acre cell using recharge wells. • 18-acre cell using four wells and traveling spray irrigation system. • Total leachate storage capacity of 40,000 gallons. • Cells lined with 30-mil PVC synthetic liner with leachate collection systems. • Average refuse depth in cells is 30 ft.
Lycoming County Landfill Williamsport, PA [Natale and Anderson, 1986]	Full-Scale Operations with Study	• Three 10-acre leachate recycle cells. • 20-mil PVC used to line cells along with leachate collection systems. • Various leachate recycle strategies attempted but not detailed. • Authors observed recharge wells to work best. • Eight years of data collection included flow measurement (collect and recycle); rainfall; landfill surface conditions (monthly); and quarterly leachate quality monitoring.

TABLE 2 (continued)

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Southwest Landfill Alachua County, Florida [Reinhart, 1996] [Townsend et al., 1996]	Full-Scale Operations with Study	• Composite lined area is 27 ac (10.9 ha). • Waste was first accepted in Spring 1988. • Receives 10,000 tons/month (9,070 Mg/month) of MSW. • Maximum waste thickness will be 65 ft (20 m). • Permitted to recirculate up to 60,000 gal/day (227 m^3/day). • Storage tank capacity is 360,000 gal (1,364 m^3). • From 1990-1992, over 8 million gal (30,000 m^3) of leachate was pumped into infiltration ponds. • In 1993, began using horizontal injection trenches (horizontal spacing of 50 ft (15 m), vertical spacing of 20 ft (6 m)). • From March through September 1993, injected 200,000 to 780,000 gal/month (757 to 2,950 m^3/month) of leachate into a total of 17 injection trenches.
Central Landfill Facility Worcester County, Maryland [Reinhart, 1996] [Kilmer, 1991]	Full-Scale Operations	• Lined area consists of four 17-ac (6.9-ha) cells. • Began operating in 1990. • Maximum fill height will be 90 ft (27 m). • Receives 200 tons/day (181 Mg/day) of MSW. • Storage tank capacity is 400,000 gal (1,514 m^3). • Leachate is recirculated using one vertical discharge well for each 2-ac (0.8-ha) area.
Winfield Landfill Columbia County, Florida [Reinhart, 1996]	Full-Scale Operations	• Current lined area is 7 ac (2.8 ha), with plans to expand to 22 ac (8.9 ha). • Began operating in 1992. • Maximum fill height will be 54 ft (16.5 m). • Receives 120 tons/day (109 Mg/day) of MSW. • Aeration lagoon capacity is 50,000 gal (189 m^3). • Permitted to recirculate using surface ponds or spraying, provided spraying is limited to a 2-week duration at any one location.
Pecan Row Landfill Loundes County, Georgia [Reinhart, 1996]	Full-Scale Operations	• The ultimate lined area will be 40 ac (16 ha). • Individual cells, 3.5 to 4 ac (1.5 to 1.6 ha) in area, are constructed approximately every 7 months. • Maximum fill height will be approximately 60 ft (18 m). • Receives 600 ton/day (544 Mg/day) of MSW. • Lagoon capacity is 821,000 gal (3,100 m^3). • Horizontal leachate injection trenches are constructed on top of each waste lift; the previous lift of trenches is abandoned when each new lift of trenches is constructed. • Cover soil is removed prior to subsequent waste placement.

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Lower Mount Washington Valley Secure Landfill Conway, New Hampshire [Reinhart, 1996]	Full-Scale Operations	• Composed of eight hydraulically separated double-lined cells, each 0.75 to 1.0 ac (0.3 to 0.4 ha) in area. • Receives 10,000 to 15,000 tons/yr (9,070 to 13,600 Mg/yr) of MSW • Storage tank capacity is 10,000 gal (38 m^3). • Filling began in January 1992, and was temporarily discontinued in November 1993. • Leachate was recirculated primarily by pre-wetting using a fire hose and also using a pipe manifold placed in a shallow excavation in daily cover.
Coastal Regional Solid Waste Management Authority Landfill Craven County, North Carolina [Reinhart, 1996]	Full-Scale Operations	• Consists of three hydraulically separated cells totaling 22 ac (8 ha) in area. • Final waste height will be approximately 50 ft (15 m). • Receives 350 tons/day (318 Mg/day) of MSW. • Aeration lagoon capacity is 2.4 million gal (9,085 m^3). • Leachate is injected using a movable vertical injection system consisting of 12 10-ft (3-m) long perforated black iron probes inserted into the landfill and connected to a manifold. • The system stays in one location for 2 to 8 days. • Leachate is injected at a pressure of 45 psi (310 kPa). • At the completion of each of the four planned lifts, horizontal trenches will be constructed in a pattern radiating from a central distribution box. Each lift of trenches will be abandoned when the subsequent lift of trenches is constructed.
Lemons Landfills Stoddard County, Missouri [Reinhart, 1996]	Full-Scale Operations	• Ultimate fill area will be 75 ac (30 ha). • Maximum fill height will be 85 ft (26 m). • Receives 300 tons/day (272 Mg/day) of MSW. • Lagoon storage capacity is 867,800 gal (3,280 m^3). • Leachate recirculation will be performed using vertical discharge wells located at 200-ft (61-m) intervals. • Leachate will be managed using two lagoons: the first lagoon will collect leachate until recirculation reduces leachate strength significantly, at which time leachate will be diverted to the second lagoon and used to irrigate closed areas of the landfill.

TABLE 2 (continued)

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Mill Seat Landfill Monroe County, New York [Reinhart, 1996]	Full-Scale Operations with Study	• The bioreactor research project involves three hydraulically separated double composite lined cells varying from 5.4 to 7.4 ac (2.2 to 3 ha) in area. • One cell serves as a control (i.e., no recirculation); two different horizontal leachate injection systems are used in the other two cells. • Cell 2 has horseshoe-shaped injection trenches at three elevations, and a storage tank capacity of 20,000 gal (76 m^3). • Cell 3 has horizontal trenches at two elevations containing pre-fabricated infiltrators, and a storage tank capacity of 20,000 gal (76 m^3). • The relative moisture content of the waste will be monitored using gypsum blocks located in the waste.
Delaware Solid Waste Authority Southern Solid Waste Management Center Sussex County, Delaware [Maier and Vasuki, 1996]	Full-Scale Operations	• Leachate was recirculated in Cells 1 and 2 using vertical injection wells from 1985 to 1994. • For Cell 3, a horizontal integrated leachate recirculation and landfill gas extraction system is planned; lifts of separate injection and extraction trenches will be installed every 20 ft (3 m) vertically.
Charles City County Landfill Charles City County, Virginia [WM Solid Waste Permit No. 531]	Full-Scale Operations	• Leachate is injected into horizontal trenches filled with shredded tires. • The landfill is operated by USA Waste.
Pine Bluff Landfill Cherokee County, Georgia [Georgia Solid Waste Permit No. 028-039 D (SL)]	Full-Scale Operations	• Leachate is injected into horizontal trenches. • The landfill is operated by USA Waste.
Quail Hollow Landfill Tulahoma, Tennessee [Tennessee Solid Waste Permit No. SNL-02-102-0101]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.
Cedar Ridge Landfill Louisberg, Tennessee [Tennessee Solid Waste Permit Number SNL-59-102-0238 EXT]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.
Southern Sanitation Landfill Russelville, Kentucky [Kentucky Solid Waste Permit Number 071-00006]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.

TABLE 3 - SUMMARY OF BENEFITS FOR LANDFILL BIOREACTORS

Decreased Leachate Management Costs
Increased Landfill Disposal Capacity
Reduced Duration of Leachate Production
Reduced Duration of Landfill Gas Generation
Improved Leachate Quality in Long-Term
Decreased Long-Term Threat of Leachate to the Environment
Increased Total Landfill Gas Generation Quantity
More Complete Degradation of Waste During Period of Active Waste Disposal

TABLE 4 - LEACHATE QUALITY IMPROVEMENT ILLUSTRATION: CENTRAL SOLID WASTE MANAGEMENT CENTER, KENT COUNTY, DELAWARE

PARAMETER	CONVENTIONAL	RECIRCULATING
Iron (mg/L)	20 - 21,000	4 - 1,095
BOD (mg/L)	20 - 40,000	12 - 28,000
COD (mg/L)	500 - 60,000	20 - 34,560
Ammonia (mg/L)	30 - 300	6 - 1,850
Chloride (mg/L)	100 - 5,000	9 - 1,884
Zinc (mg/L)	6 - 370	0.1 - 66

Source: Watson, R. [1995].

TABLE 5 - DESIGN GOALS FOR BIOREACTOR LANDFILLS

GOAL	APPROACH FOR ACHIEVING GOAL
1. Apply leachate and stormwater in a quantity of at least 4,000,000 gallons per year at Maplewood and 8,000,000 gallons per year at King George.	Design trenches to have a liquid application capacity of at least 8,000,000 gallons for the Maplewood Landfill and 8,000,000 gallons for the King George Landfill.
2. Minimize Seeps	• Apply liquid at least 50 ft from edge of waste • Inspect landfill weekly for the presence of seeps • Repair seeps as quickly as possible
3. Provide several liquid delivery options	Provide different approaches for delivering liquid to the working face (e.g., pumped directly from leachate storage tanks or stormwater pond, temporarily stored in tanks near the working face, etc.).
4. Uniformly distribute liquid throughout waste	Design leachate application trenches in a configuration that maximizes amount of waste affected by recirculated leachate.
5. Minimize uncontrolled release of landfill gas	Design and install a landfill gas collection system that can be operated throughout the active life of the bioreactor program.
6. Monitor performance of bioreactor program	Monitor performance of bioreactor program and report results of monitoring program semi-annually to WM.

TABLE 6 - METHODS FOR MEASURING ENVIRONMENTAL PERFORMANCE OF LANDFILL BIOREACTOR PROGRAM

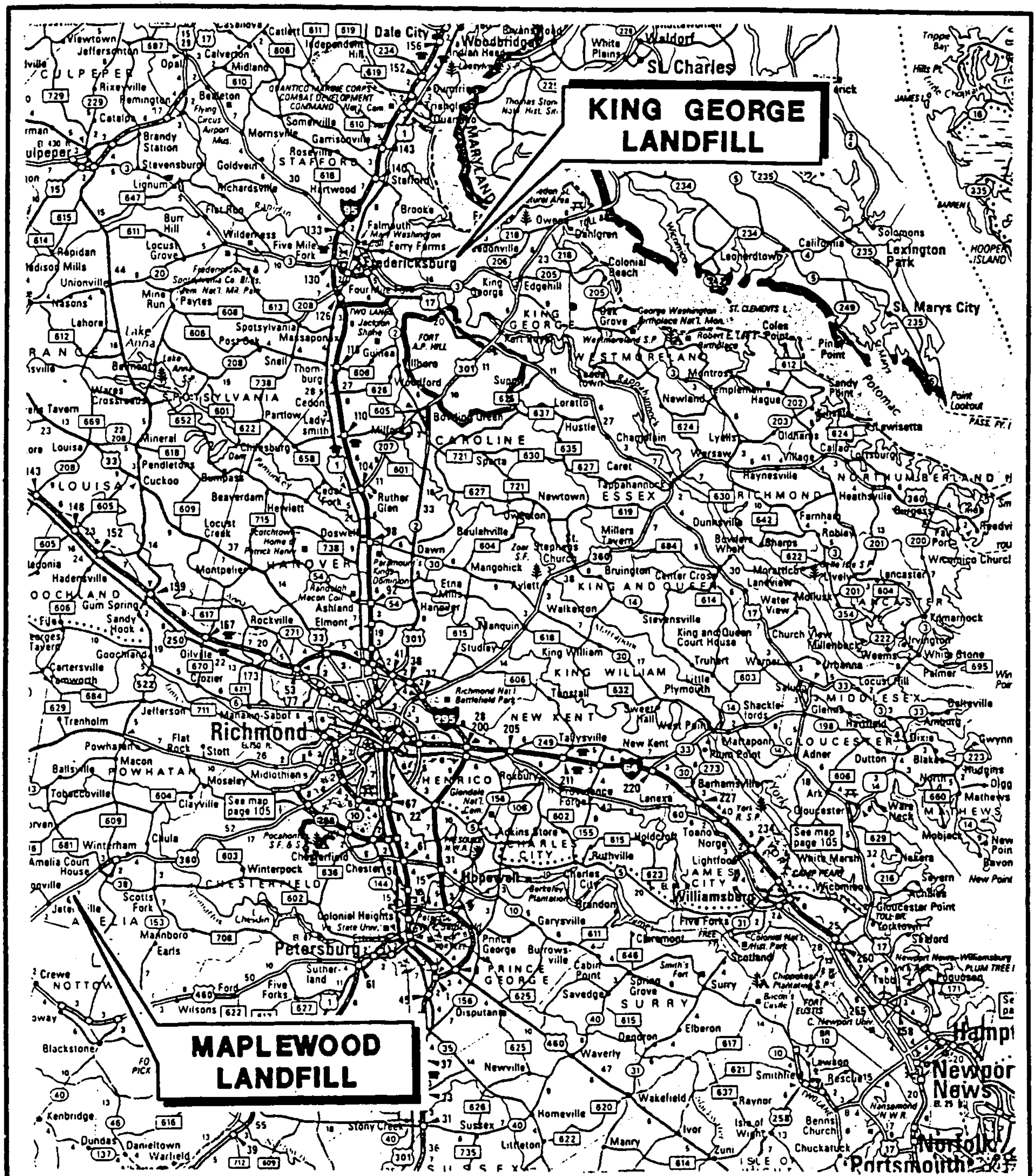
CRITERIA	DESCRIPTION	APPLICATION
Settlement	Measurement of total settlement of surface of waste over a period of time	Compare the surveyed elevation of the top surface of the bioreactor before bioreactor operation to the elevation during and after bioreactor operation
Leachate Quantity	Total volume of leachate collected from bioreactor cell	Measure leachate quantity from flowmeters in leachate riser houses located at each bioreactor cell
Leachate Quality	Chemical characteristics of leachate collected from a bioreactor cell	Perform laboratory analyses of the chemical characteristics of leachate from bioreactor cells
In-Place Density	Unit weight of waste in a bioreactor cell	Divide the total weight of waste placed in a bioreactor cell (based on scale records) by the total surveyed volume of the waste (i.e., difference in elevation between the bottom and the top of the bioreactor cell)
Odors	Potential complaints of odors from site	Track frequency of odor complaints during and after liquids application events
Seeps	Breakouts of leachate on sideslopes	Track occurrence of seeps and correlate them to liquids application events
Operational Problems	Assess operational efficiency caused by liquids application	Monitor the working face for occurrences of operational problems caused by liquids applications
Leachate Collection Systems	Liquid quantity occurring in the detection zone	Compare liquid flowrate in detection zone during liquids application period to flowrate in detection zone before liquids application period

TABLE 7 PRELIMINARY OUTLIINE FOR PROJECT XL SEMI-ANNUAL REPORT

[TO BE DEVELOPED]

FIGURES

PROJECT LOCATION MAP
KING GEORGE COUNTY LANDFILL AND RECYCLING CENTER
AND
MAPLEWOOD RECYCLING AND WASTE DISPOSAL FACILITY



MAP SOURCE:
ROAD ATLAS, UNITED STATES, CANADA, MEXICO,
RAND MCNALLY 1999.

17 8.5 0 17
APPROXIMATE SCALE: 1" = 17 MILES

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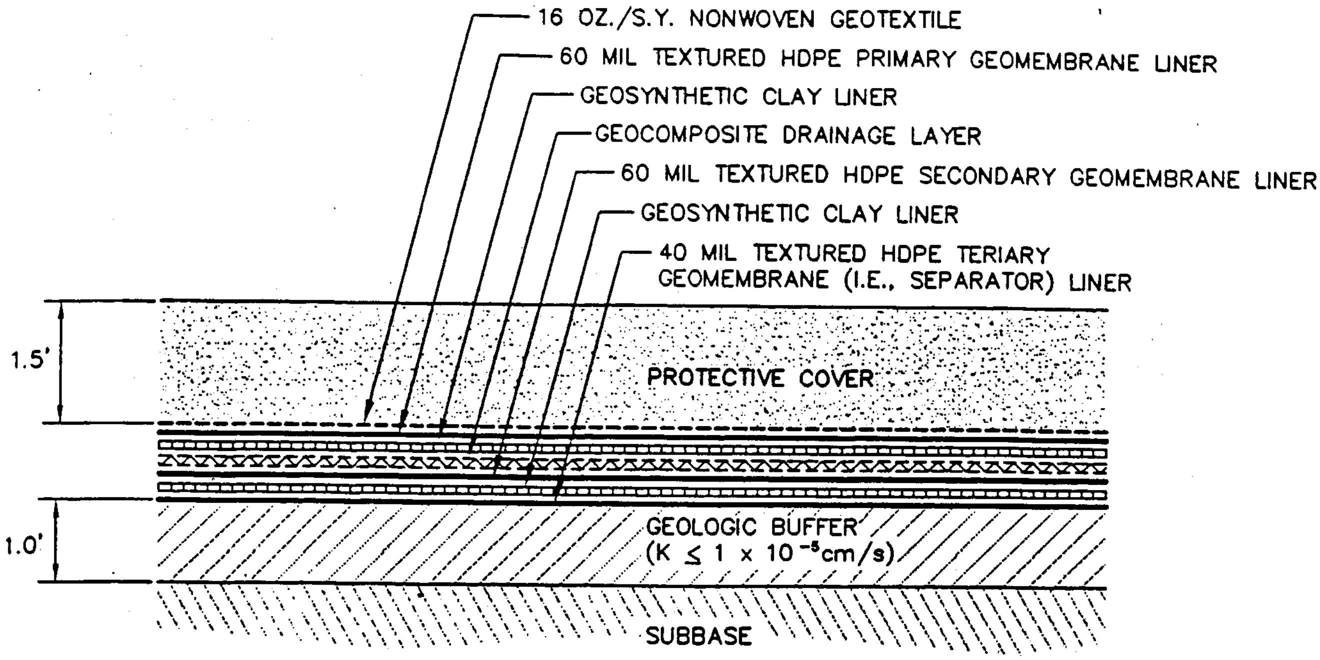
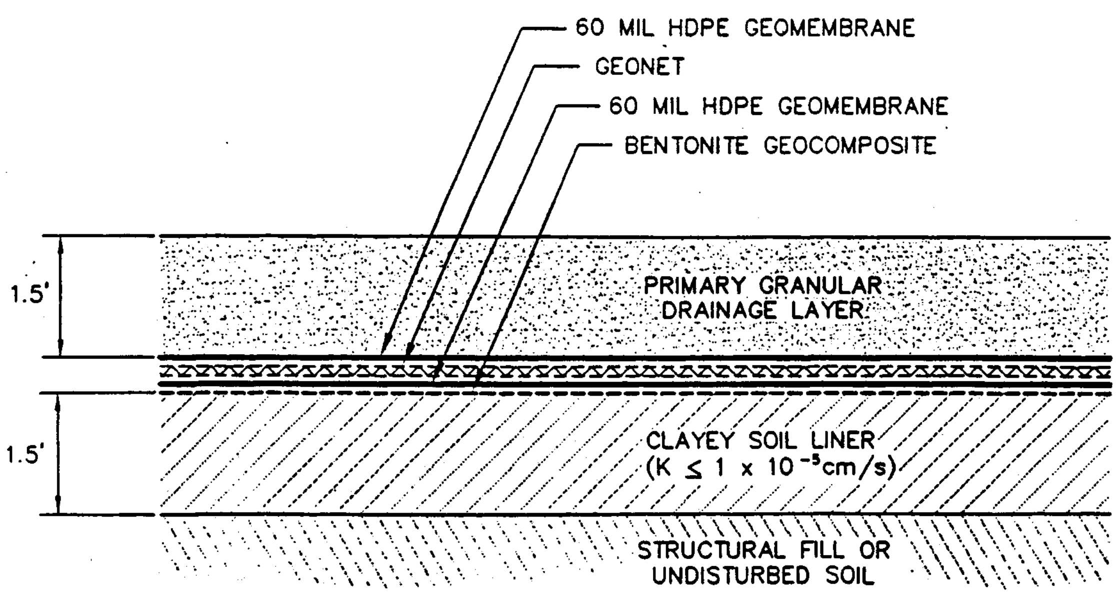
FIGURE NO.	1
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169P008

CELL BASE LINER SYSTEMS



KING GEORGE COUNTY LANDFILL AND RECYCLING CENTER



MAPLEWOOD RECYCLING AND WASTE DISPOSAL FACILITY

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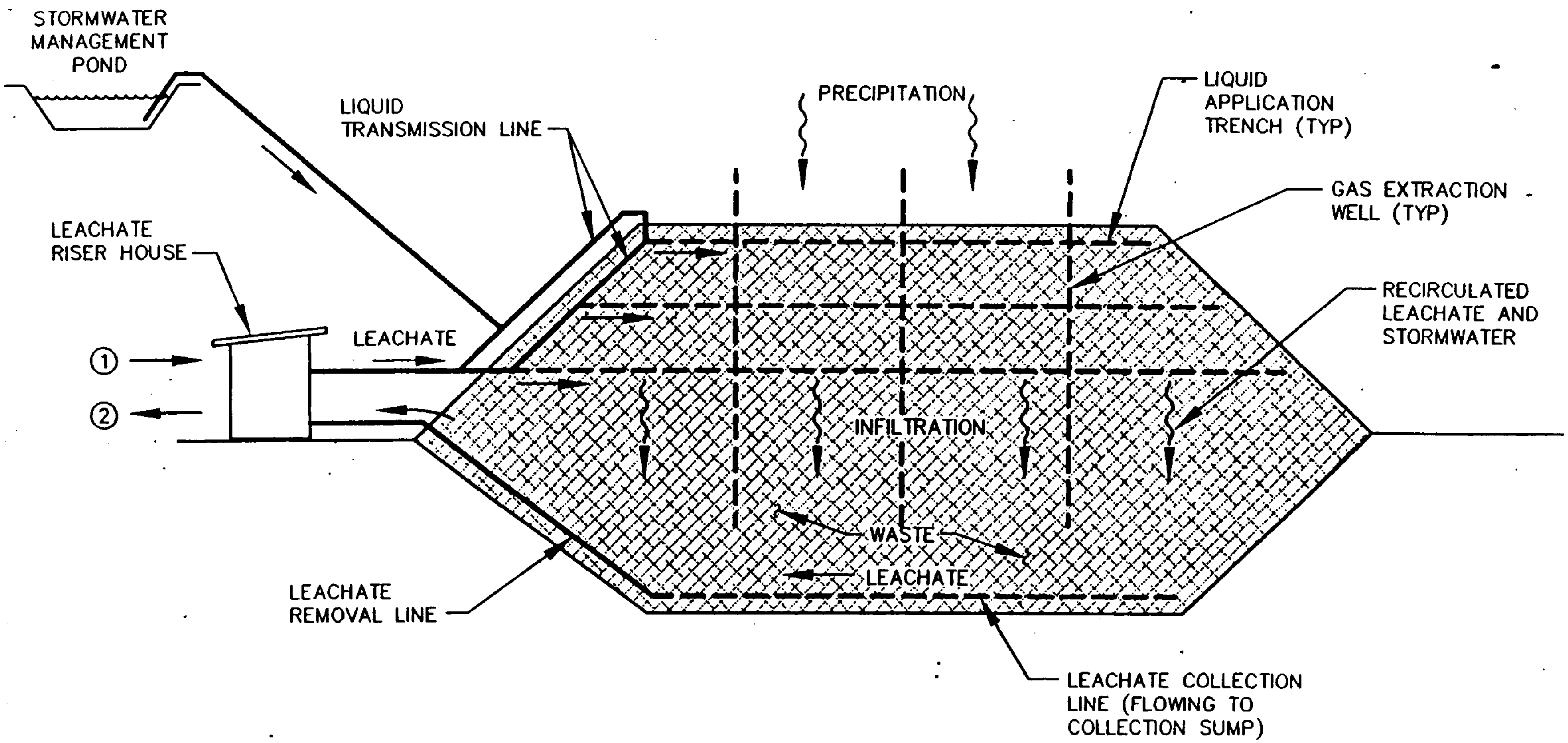
FIGURE NO.	2
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169P006

PROCESS FLOW DIAGRAM – BIOREACTOR

KING GEORGE COUNTY LANDFILL AND RECYCLING CENTER – KING GEORGE COUNTY, VIRGINIA
AND
MAPLEWOOD RECYCLING AND WASTE DISPOSAL FACILITY – AMELIA COUNTY, VIRGINIA



① FROM LEACHATE STORAGE TANKS (IF WASTE CAN RECEIVE MORE LEACHATE THAN AVAILABLE FROM LEACHATE COLLECTION LINE)

② LEACHATE OVERFLOW TO STORAGE TANKS (ONLY IF LIQUID APPLICATION TRENCHES CANNOT ACCEPT LIQUID IN TRENCHES OR HEAD ON LINER IS GREATER THAN ONE FOOT)

NOT TO SCALE

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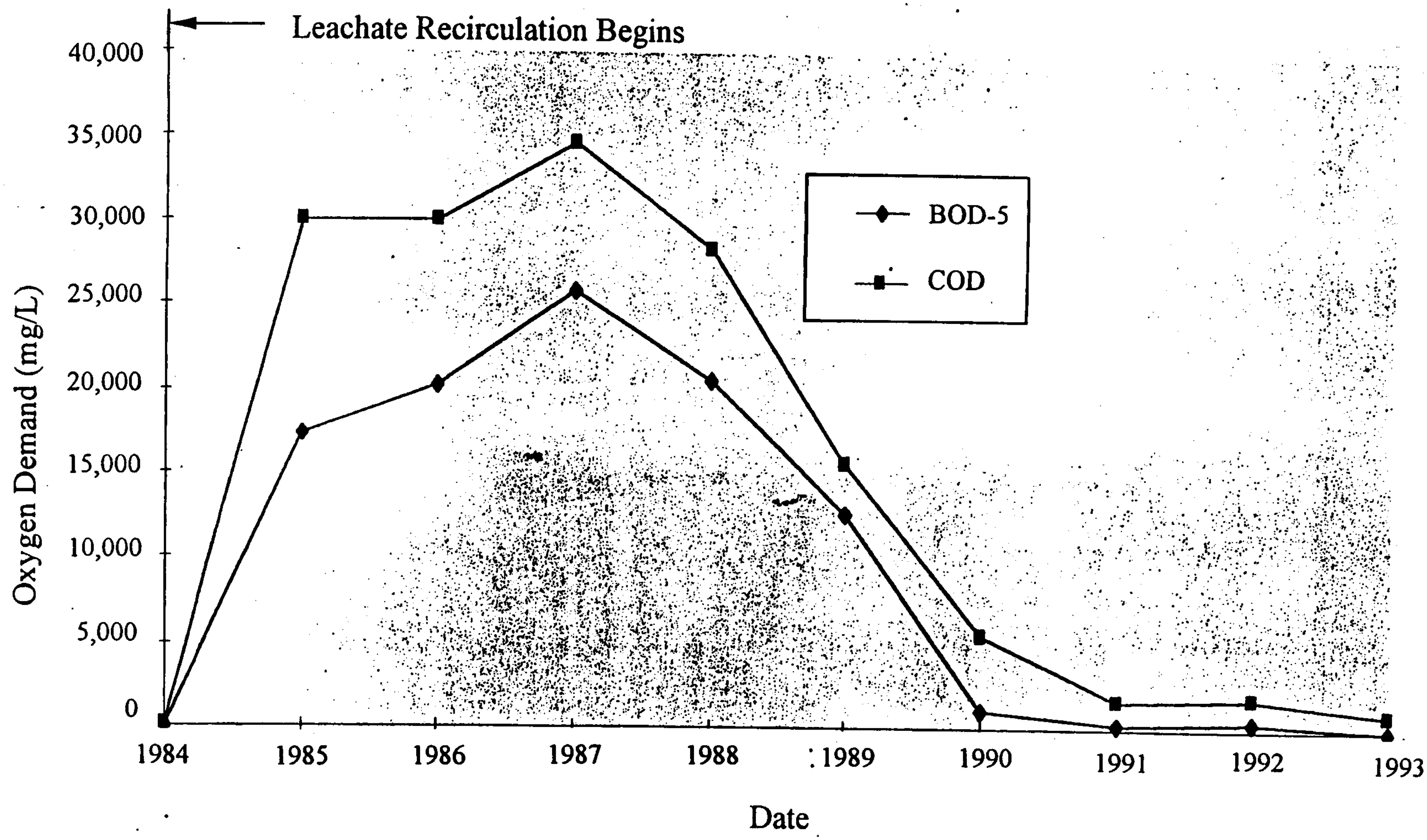
FIGURE NO.	3
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169P007

TYPICAL EXAMPLE: IMPROVEMENT IN LEACHATE QUALITY



SOURCE:
CSWMC, AREA B, DSWA

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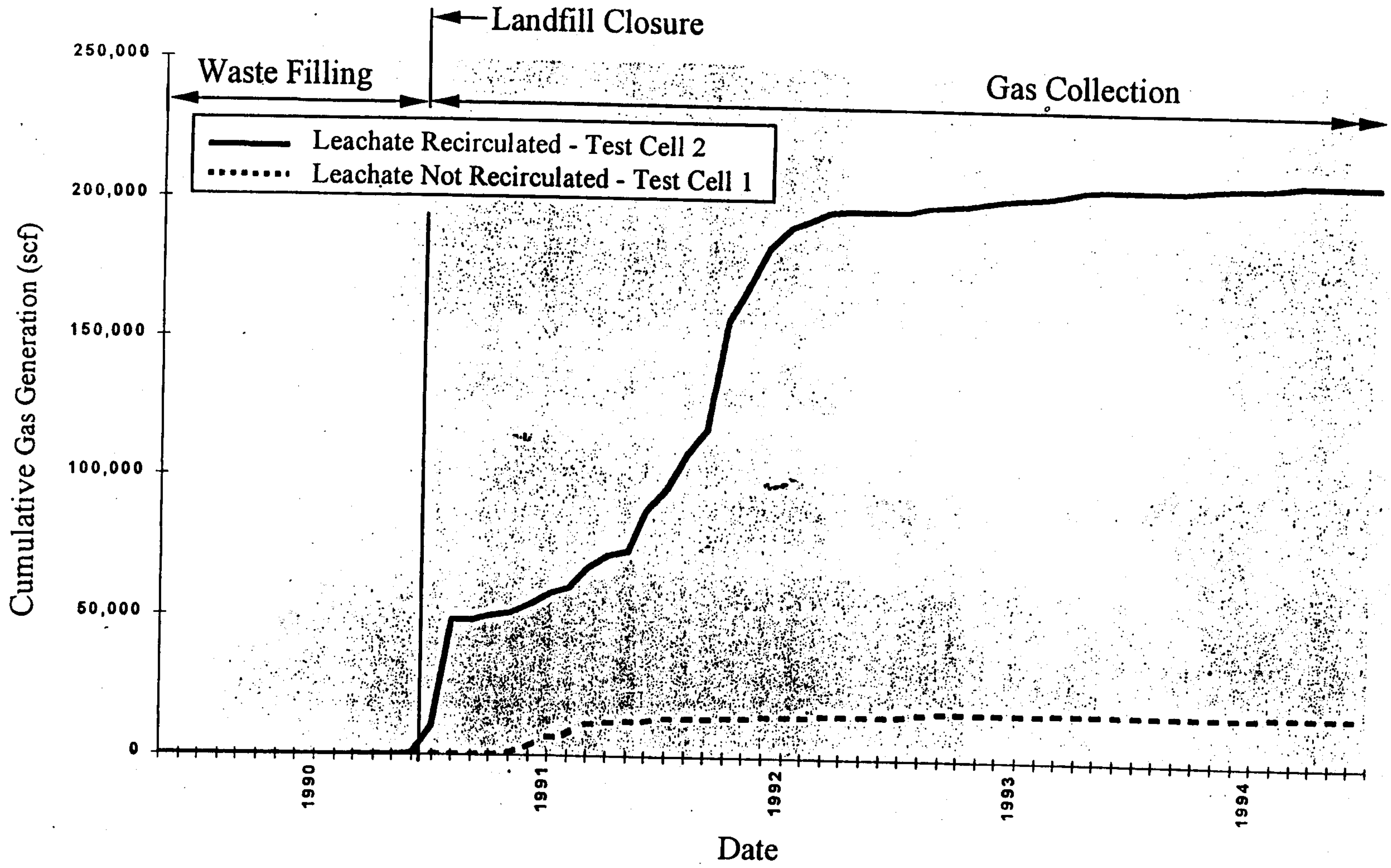
FIGURE NO.	4
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169P003

TYPICAL EXAMPLE: CUMULATIVE GAS GENERATION



SOURCE:
CSWMC TEST CELLS, DSWA, SANDTOWN, DELAWARE

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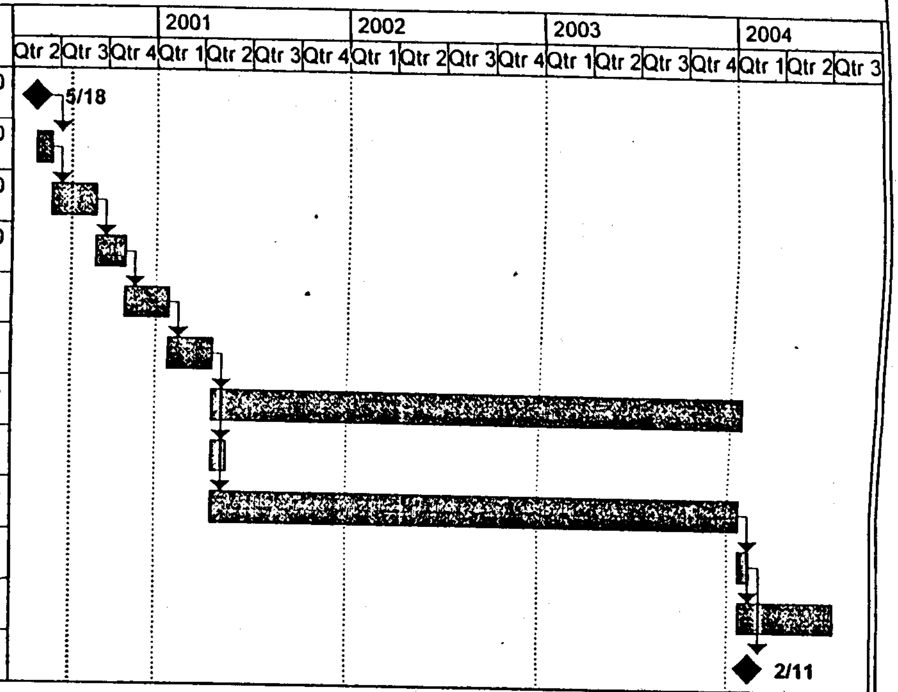
FIGURE NO.	5
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169P003

PRELIMINARY PROJECT SCHEDULE

PROJECT XL LANDFILL BIOREACTORS
MAPLEWOOD AND KING GEORGE LANDFILLS, VIRGINIA

ID	Task Name	Duration	Start	Finish
1	Submit Application for Project XL	0 days	Thu 5/18/00	Thu 5/18/00
2	USEPA Review	4 wks	Thu 5/18/00	Wed 6/14/00
3	FPA Negotiation	12 wks	Thu 6/15/00	Wed 9/6/00
4	WM Prepares Amendment to Permit	8 wks	Thu 9/7/00	Wed 11/1/00
5	VADEQ Finalize Amendment	12 wks	Thu 11/2/00	Wed 1/24/01
6	Construct Bioreactor Systems	12 wks	Thu 1/25/01	Wed 4/18/01
7	Operation Period	144 wks	Thu 4/19/01	Wed 1/21/04
8	Background Monitoring	4 wks	Thu 4/19/01	Wed 5/16/01
9	Operations Monitoring	144 wks	Thu 4/19/01	Wed 1/21/04
10	Prepare Final Report	3 wks	Thu 1/22/04	Wed 2/11/04
11	Cell Closure	26 wks	Thu 1/22/04	Wed 7/21/04
12	Submit Final Report to VADEQ	0 days	Wed 2/11/04	Wed 2/11/04



Project: SCHEDULE
Date: Fri 7/21/00

Task	Summary	Rolled Up Progress	
Split	Rolled Up Task	External Tasks	
Progress	Rolled Up Split	Project Summary	
Milestone	Rolled Up Milestone		

TABLES

TABLE 1

SUMMARY OF FIELD-SCALE LEACHATE RECIRCULATION PROJECTS

Leachate Recirculation Plan
King George County Landfill and Recycling Facility
King George, Virginia

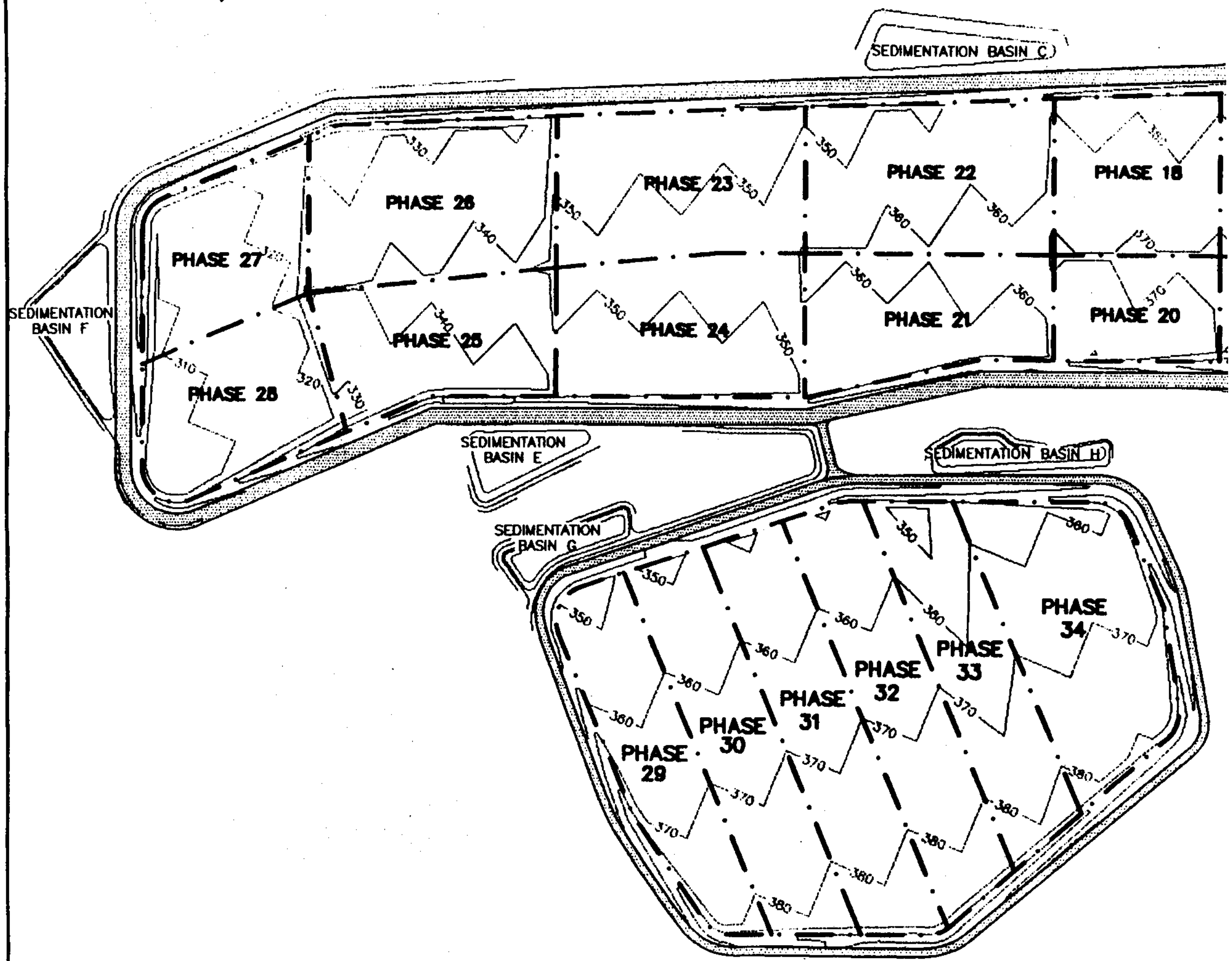
PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Yorkshire, England Scarner-Carr Landfill [Robinson and Maris, 1985]	Field-Scale Study	• 6.2-acre cell used as leachate recycle area. • Approximate 6-acre control area. • Cell lined with 100-mil HDPE with leachate collection system. • 13 ft of pulverized refuse placed in cells. • Leachate redistributed by spray pipe networks laid on top of refuse. • Furrows later dug into surface to reduce ponding. • Recirculation and monitoring period approximately 3 years. • 36,000 gallons of leachate storage available.
Delaware Solid Waste Authority Central Solid Waste Management Center Sandtown, Delaware [Vasuki, 1986]	Field-Scale Study	• Leachate recycle in 2 full-scale landfill cells. • 9-acre cell using recharge wells. • 18-acre cell using four wells and traveling spray irrigation system. • Total leachate storage capacity of 40,000 gallons. • Cells lined with 30-mil PVC synthetic liner with leachate collection systems. • Average refuse depth in cells is 30 ft.
Lycoming County Landfill Williamsport, PA [Natale and Anderson, 1986]	Full-Scale Operations with Study	• Three 10-acre leachate recycle cells. • 20-mil PVC used to line cells along with leachate collection systems. • Various leachate recycle strategies attempted but not detailed. • Authors observed recharge wells to work best. • Eight years of data collection included flow measurement (collect and recycle); rainfall; landfill surface conditions (monthly); and quarterly leachate quality monitoring.
Southwest Landfill Alachua County, Florida [Reinhart, 1996] [Townsend et al., 1996]	Full-Scale Operations with Study	• Composite lined area is 27 ac (10.9 ha). • Waste was first accepted in Spring 1988. • Receives 10,000 tons/month (9,070 Mg/month) of MSW. • Maximum waste thickness will be 65 ft (20 m). • Permitted to recirculate up to 60,000 gal/day (227 m^3/day). • Storage tank capacity is 360,000 gal (1,364 m^3). • From 1990-1992, over 8 million gal (30,000 m^3) of leachate was pumped into infiltration ponds. • In 1993, began using horizontal injection trenches (horizontal spacing of 50 ft (15 m), vertical spacing of 20 ft (6 m)). • From March through September 1993, injected 200,000 to 780,000 gal/month (757 to 2,950 m^3/month) of leachate into a total of 17 injection trenches.
Central Landfill Facility Worcester County, Maryland [Reinhart, 1996] [Kilmer, 1991]	Full-Scale Operations	• Lined area consists of four 17-ac (6.9-ha) cells. • Began operating in 1990. • Maximum fill height will be 90 ft (27 m). • Receives 200 tons/day (181 Mg/day) of MSW. • Storage tank capacity is 400,000 gal (1,514 m^3). • Leachate is recirculated using one vertical discharge well for each 2-ac (0.8-ha) area.

TABLE 1
(continued)

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Mill Seat Landfill Monroe County, New York [Reinhart, 1996]	Full-Scale Operations with Study	• The bioreactor research project involves three hydraulically separated double composite lined cells varying from 5.4 to 7.4 ac (2.2 to 3 ha) in area. • One cell serves as a control (i.e., no recirculation); two different horizontal leachate injection systems are used in the other two cells. • Cell 2 has horseshoe-shaped injection trenches at three elevations, and a storage tank capacity of 20,000 gal (76 m^3). • Cell 3 has horizontal trenches at two elevations containing pre-fabricated infiltrators, and a storage tank capacity of 20,000 gal (76 m^3). • The relative moisture content of the waste will be monitored using gypsum blocks located in the waste.
Delaware Solid Waste Authority Southern Solid Waste Management Center Sussex County, Delaware [Maier and Vasuki, 1996]	Full-Scale Operations	• Leachate was recirculated in Cells 1 and 2 using vertical injection wells from 1985 to 1994. • For Cell 3, a horizontal integrated leachate recirculation and landfill gas extraction system is planned; lifts of separate injection and extraction trenches will be installed every 20 ft (3 m) vertically.
Charles City County Landfill Charles City County, Virginia [VADEQ Solid Waste Permit No. 531]	Full-Scale Operations	• Leachate is injected into horizontal trenches filled with shredded tires. • The landfill is operated by USA Waste.
Pine Bluff Landfill Cherokee County, Georgia [Georgia Solid Waste Permit No. 028-039 D (SL)]	Full-Scale Operations	• Leachate is injected into horizontal trenches. • The landfill is operated by USA Waste.
Quail Hollow Landfill Tulahoma, Tennessee [Tennessee Solid Waste Permit No. SNL-02-102-0101]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.
Cedar Ridge Landfill Louisberg, Tennessee [Tennessee Solid Waste Permit Number SNL-59-102-0238 EXT]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.
Southern Sanitation Landfill Russelville, Kentucky [Kentucky Solid Waste Permit Number 071-00006]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.

FIGURES

MAPLEWOOD RECYCLING AND WA



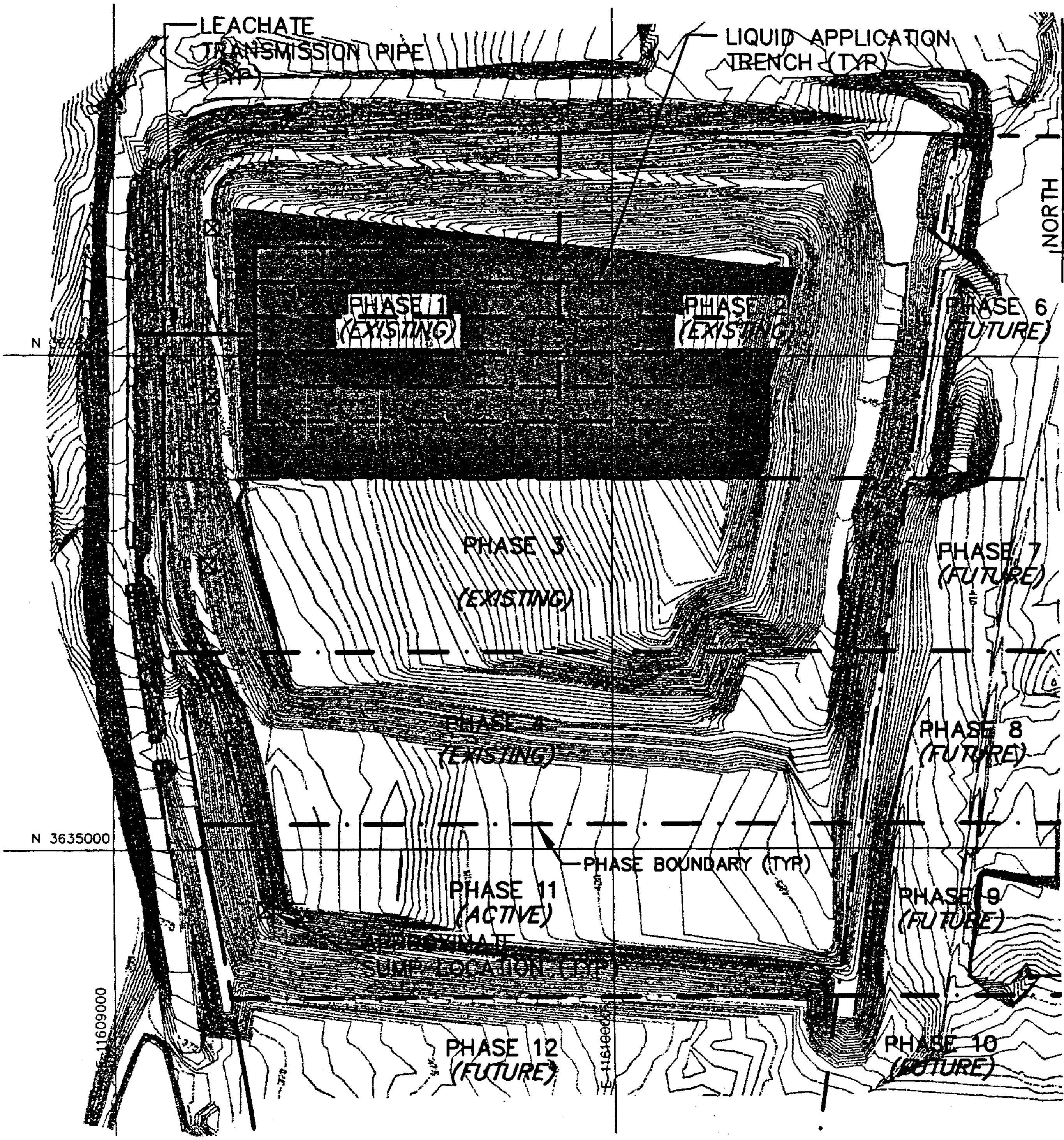
NOTES:

1. MSL = MEAN SEA LEVEL
2. GRADING INFORMATION OBTAINED FROM GZA [1994].

LEGENI

- PHASE BOUNI
- TOP OF LEACI
- PERIMETER AC

CONCEPTUAL BIOREACTOR SYSTEM LAYOUT
MAPLEWOOD RECYCLING AND WASTE DISPOSAL FACILITY



NOTES:

1. SURVEY BY FLORA SURVEYING ASSOCIATES, INC., DATED OCTOBER 1999.
2. PHASES 4 AND 11 ARE CONTROL CELLS.

300 150 0 300
SCALE IN FEET

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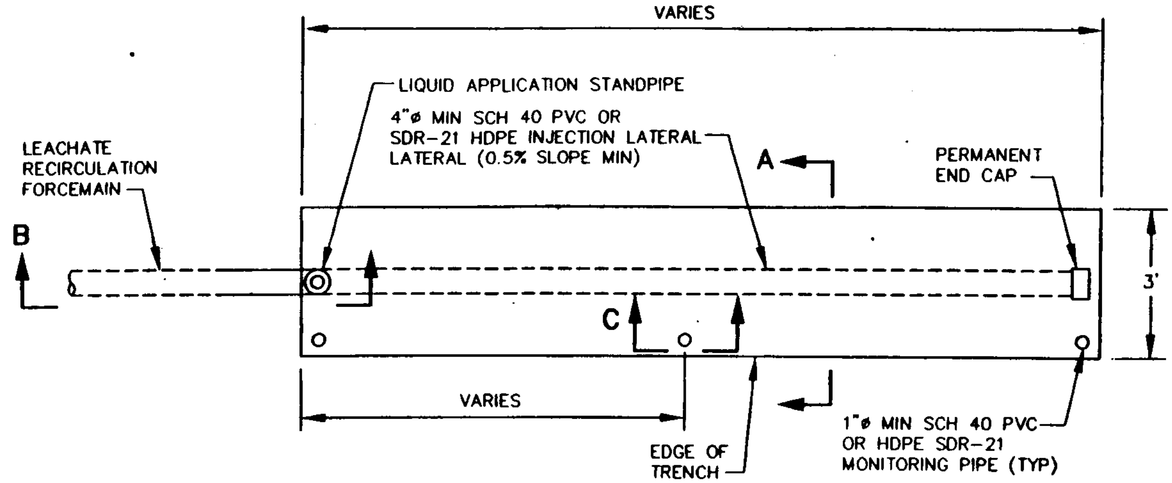
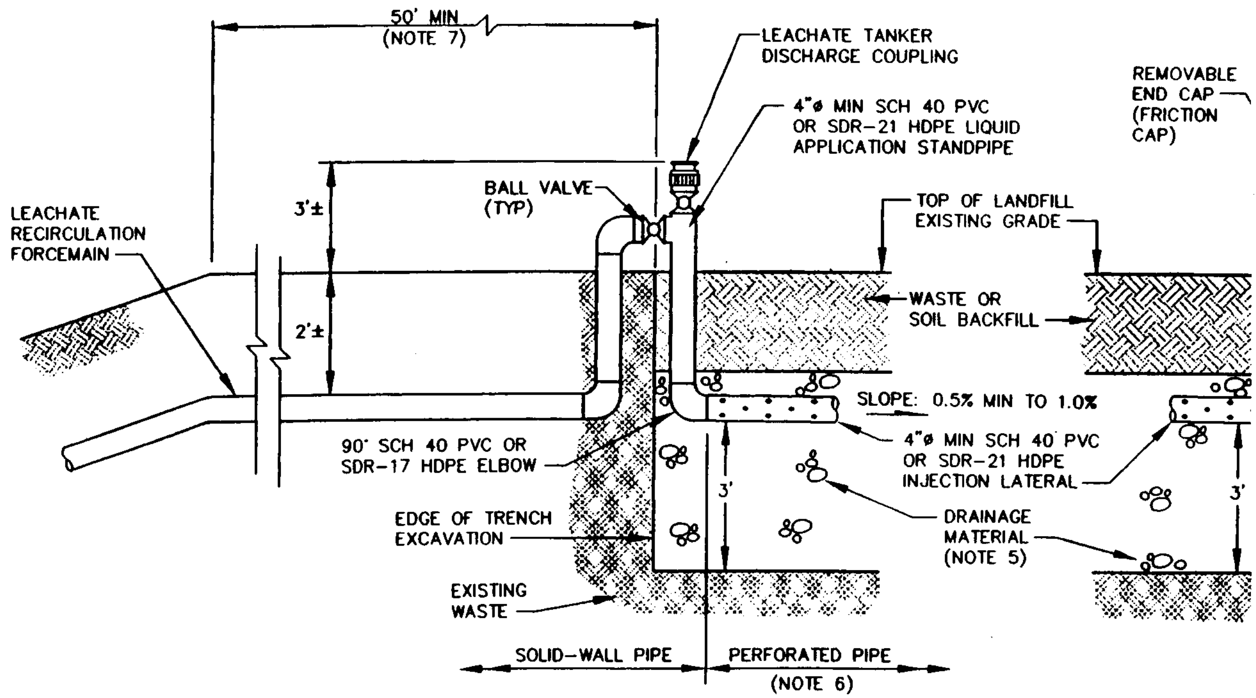
FIGURE NO.	2
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169P002

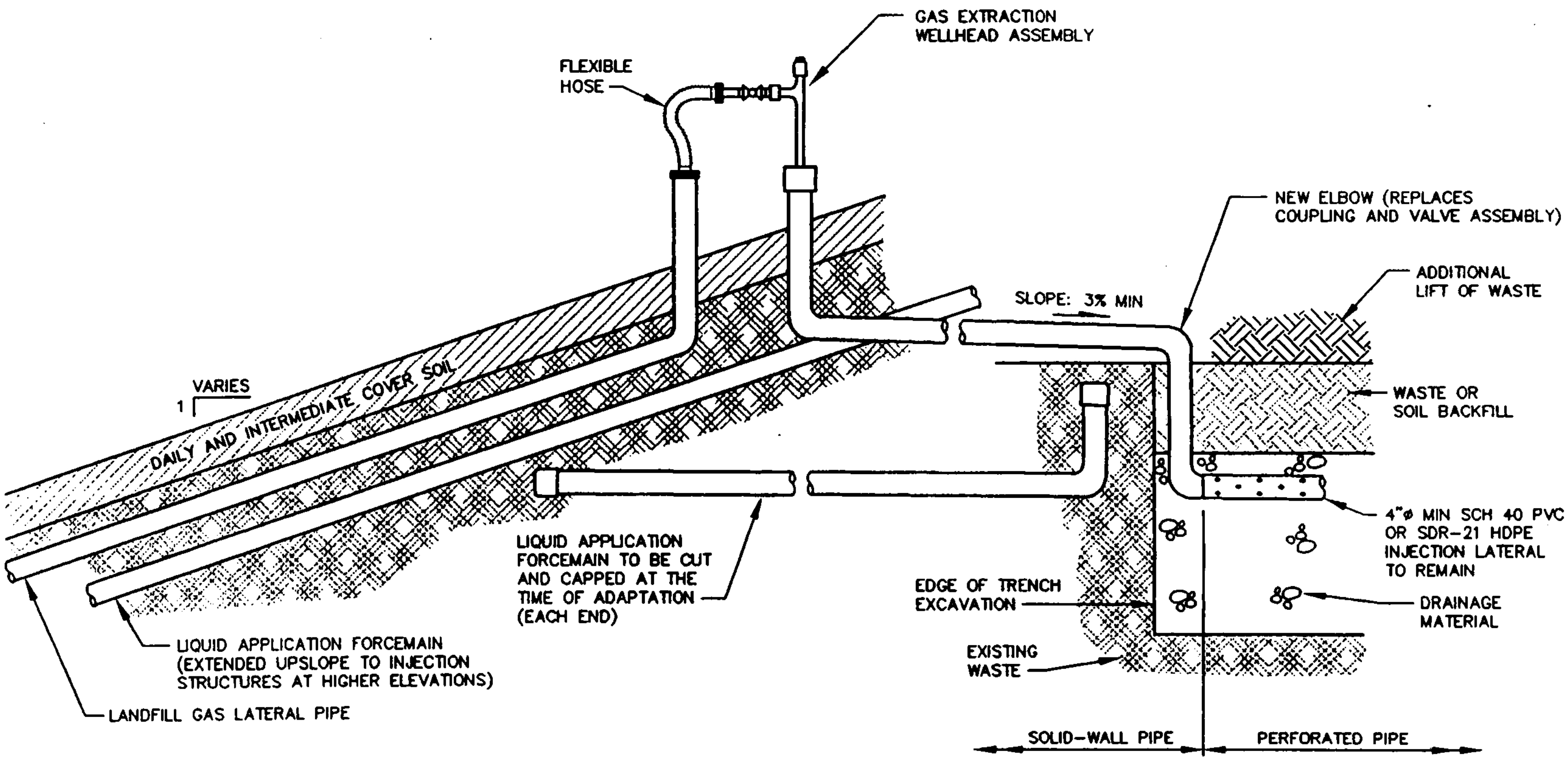


1 — PLAN
PROPOSED LIQUID APPLICATION TRENCH
NOT TO SCALE



B — SECTION B
PROPOSED LIQUID APPLICATION
TRENCH AT STANDPIPE
NOT TO SCALE

C — SECTI
PROP
TRENC
NOT TO S



NOTES:

1. THIS IS A CONCEPTUAL PLAN SHOWING ONE POSSIBLE PIPING CONFIGURATION. THE FOLLOWING ASSUMPTIONS WERE MADE:
   (i) THE TRENCH SHOWN IS NOT IN THE UPPERMOST LIFT OF WASTE; AND
   (ii) WASTE PLACEMENT IS CONTINUING AT A HIGHER ELEVATION THAN SHOWN IN THIS FIGURE.
2. WASTE MANAGEMENT MAY CHOOSE TO CONTINUE APPLYING LEACHATE INTO A TRENCH AFTER IT HAS BEEN ADAPTED FOR LANDFILL GAS EXTRACTION.

NOT TO SCALE

LIQUID APPLICATION TRENCH ADAPTED FOR LANDFILL GAS EXTRACTION

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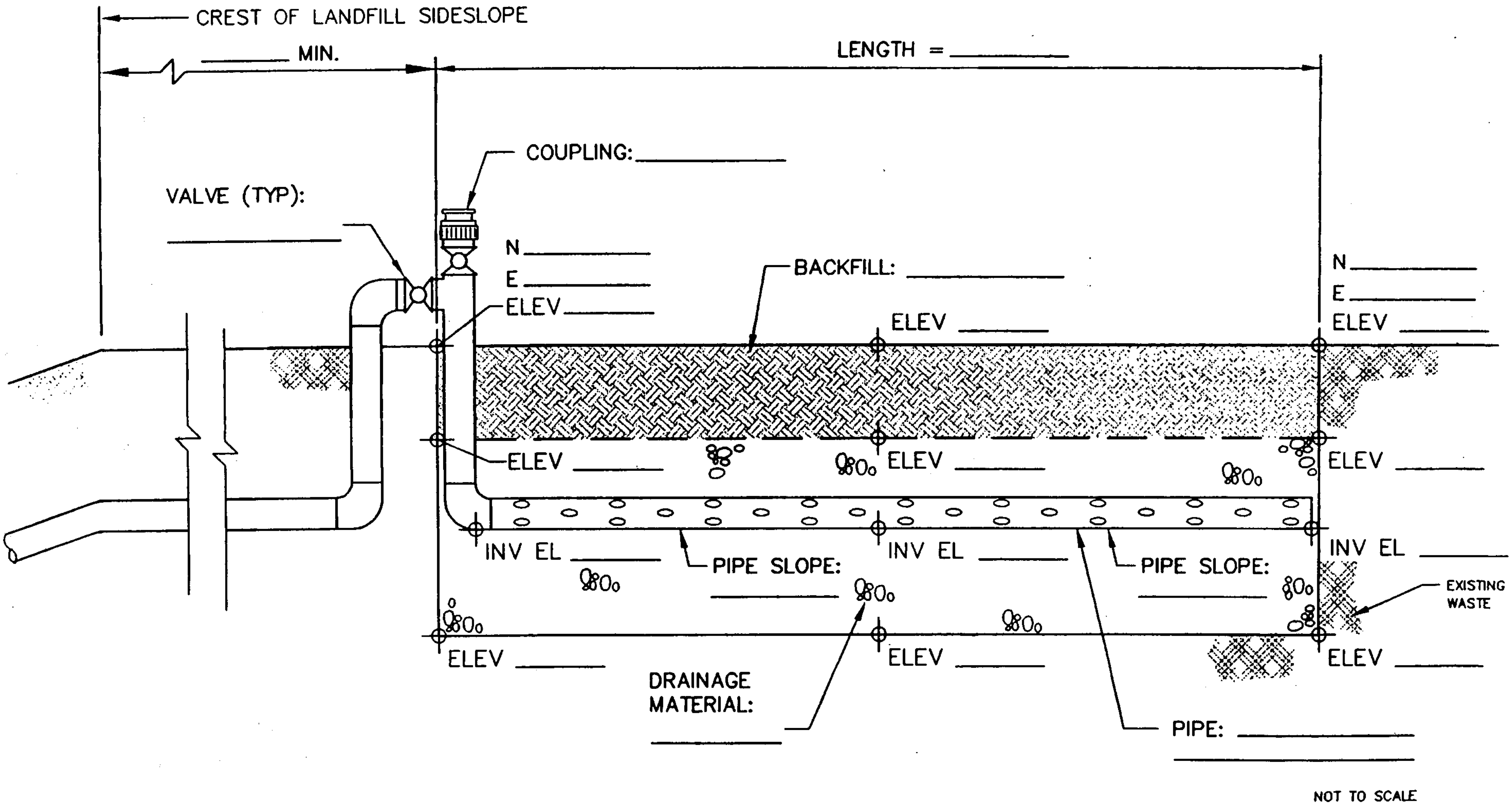
FIGURE NO.	4
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169F004

TRENCH NO.: ____________________

DATE CONSTRUCTED : ____________________



TRENCH CONSTRUCTION LOG

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FIGURE NO.	5
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169F005

APPENDIX A

Evaluation of Leachate Head on Liner

COMPUTATION COVER SHEET

Client: WMI **Project:** Leach. Recirculation **Project/Proposal#:** ME0169 **Task #:** 02

TITLE OF COMPUTATIONS EVALUATION OF LEACHATE HEAD ON LINER - MAPLEWOOD

COMPUTATIONS BY:
Signature Douglas T. Mandeville
Printed Name and Title: Douglas T. Mandeville, Staff Engineer
DATE 5/23/00

ASSUMPTIONS AND PROCEDURES CHECKED BY: (Peer Reviewer)
Signature MFHoulihan
Printed Name and Title: Michael F. Houlihan, Principal
DATE 5/25/00

COMPUTATIONS CHECKED BY:
Signature MFHoulihan
Printed Name and Title: Michael F. Houlihan, Principal
DATE 5/25/00

COMPUTATIONS BACKCHECKED BY: (Originator)
Signature Douglas T. Mandeville
Printed Name and Title: Douglas T. Mandeville, Staff Engineer
DATE 5/25/00

APPROVED BY: (PM or Designate)
Signature MFHoulihan
Printed Name and Title: Michael F. Houlihan, Principal
DATE 5/25/00

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

ME0169/MD00117.MPL.CAL

Written by: Doug Mandeville Date: 05 / 23 / 00 Reviewed by: ________________ Date: 05/30/00

Client: Waste Management, Inc. Project: Maplewood Leach. Recirc. Proj./Proposal No.: ME0169 Task No.: 2

EVALUATION OF LEACHATE HEAD ON LINER

1. OBJECTIVE

The objective of this evaluation is to estimate the effect of leachate recirculation on the hydraulic head on the liner of the Maplewood Recycling and Waste Disposal Facility (Maplewood facility). State regulations (VR-672-20-10, Section 5.5) require that the hydraulic head on a landfill liner be maintained below 12 in. (300 mm).

2. METHODOLOGY

The methodology and input parameter values that were used are based on those previously used by others to estimate leachate quantities for the Maplewood facility, as presented in Appendix E of the approved Part B Solid Waste Permit Application (Part B) [Donohue 1991]. Both the previous and current evaluations were performed using the Hydrologic Evaluation of Landfill Performance (HELP) Model, version 3 [USEPA 1994a,b]. To simulate the effect of leachate recirculation a constant subsurface inflow was added to the waste.

3. EVALUATION OF HYDRAULIC HEAD ON LINER

For the leachate collection and liner material properties were identical to those used by Donohue [1991]. The default properties supplied by the HELP model were used for waste ($k = 2.4 \times 10^{-4}$ cm/s). The area analyzed was considered to have an area of 10 acres and a waste thickness of 80 feet.

The HELP analyses were performed to evaluate the maximum rate of leachate recirculation for which the maximum calculated head on the liner is less than 12 in. (300 mm). The anticipated rate of leachate circulation was assumed to be 4,000,000 gallons per year. This number was based on previous leachate generation values from the Maplewood facility. A portion of this amount of water will be consumed during the methanogenesis process that turns cellulose into carbon dioxide, methane, and water vapor. This calculation of water consumption during biodegradation is shown below.

net inflow = 4,000,000 - 2,500,000 = 1,500,000 gallons/year ;

1,500,000 gallons/year over 10 acres = 150,000 gallons/acre/year

= 150,000 gallons/acre/year x 12 inches/foot x gallon/7.48 ft^3 x acre/43560 ft^2
= 5.52 in/year.

This is accounted for in the HELP analysis by adding a subsurface inflow to layer 2 of 5.52 inches per year.

4. RESULTS AND CONCLUSIONS

Based on this evaluation, it is concluded that, for a waste thickness of 80 ft (24 m), applying leachate at the rate of 5.52 inches per year will result in a hydraulic head on the liner no greater than 5.2 in. This is less than the required maximum value of 12 in.

5. REFERENCES

Donohue, "*Part B Permit Application, Maplewood Recycling and Waste Disposal Facility*", prepared for Chambers Waste Systems of Virginia, Inc., by Donohue & Associates, Inc., Sheboygan, Wisconsin, May 1991.

Leszkiewicz, J.J., and McAulay, P.B., "Municipal Solid Waste Landfill Bioreactor Technology: Closure and Postclosure Issues", US Environmental Protection Agency Seminar Publication: Landfill Bioreactor Design and Operation, EPA/600/R-95/146, USEPA, Washington, DC, September 1995.

USEPA, "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, Vol. I, Users Guide for Version 3*", EPA/530-SW-84-009, US Environmental Protection Agency, Washington, DC, June 1994a, 120p.

USEPA, "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, Vol. II, Users Guide for Version 3*", EPA/530-SW-84-010, US Environmental Protection Agency, Washington, DC, June 1994b, 120p.

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4300	VOL/VOL
FIELD CAPACITY	=	0.3663	VOL/VOL
WILTING POINT	=	0.2802	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999997000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	91.61	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	10.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.268	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.930	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.150	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	249.697	INCHES
TOTAL INITIAL WATER	=	249.697	INCHES
TOTAL SUBSURFACE INFLOW	=	5.52	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RICHMOND VIRGINIA

STATION LATITUDE	=	37.50 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	103
END OF GROWING SEASON (JULIAN DATE)	=	303
EVAPORATIVE ZONE DEPTH	=	10.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RICHMOND VIRGINIA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.53	1.81	2.89	1.92	3.60	3.82
4.56	4.95	3.03	2.54	3.41	3.66

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RICHMOND VIRGINIA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
32.10	36.80	46.10	55.40	63.40	72.50
76.10	74.20	68.00	55.90	48.40	38.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RICHMOND VIRGINIA
AND STATION LATITUDE = 37.50 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.65	1.94	3.10	2.06	3.92	4.11
	4.89	5.31	3.26	2.73	3.66	3.93
STD. DEVIATIONS	0.18	0.79	1.32	1.39	2.11	1.84
	0.94	1.47	1.09	1.98	1.04	2.71
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.039	1.492	2.663	2.238	3.373	3.537
	4.486	3.133	2.527	2.041	1.749	0.979
STD. DEVIATIONS	0.307	0.531	0.310	0.891	1.411	1.426
	0.654	1.206	0.776	0.809	0.536	0.192
SUBSURFACE INFLOW INTO LAYER 2						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0470	0.0338	0.0689	0.0992	0.1277	0.1196
	0.1371	0.1230	0.1260	0.1205	0.1131	0.1333
STD. DEVIATIONS	0.0751	0.0586	0.1421	0.2084	0.2350	0.1921
	0.2417	0.2163	0.2170	0.2047	0.1808	0.1936
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0010	0.0008	0.0016	0.0023	0.0029	0.0027
	0.0031	0.0028	0.0027	0.0025	0.0024	0.0028

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.45	8893.500
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	0.01956	70.99905
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000411	1.49146
AVERAGE HEAD ON TOP OF LAYER 4	3.020	
MAXIMUM HEAD ON TOP OF LAYER 4	5.214	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	33.6 FEET	
DRAINAGE COLLECTED FROM LAYER 5	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000	
MAXIMUM HEAD ON TOP OF LAYER 6	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	2.20	7995.6484
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4203
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.2150

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	2.2100	0.3683
2	317.3286	0.3306
3	1.5294	0.0850
4	0.0000	0.0000
5	1.3421	0.1118
6	5.1600	0.4300
SNOW WATER	0.000	

APPENDIX B

Liquid Application Trench Capacity

Written by: T. B. Maier/M. Houlihan Date: 05/02/00 Reviewed by: RDE Date: 05/02/00

Client: Waste Management, Inc. Project: Maplewood Bioreactor. Proj./Proposal No.: ME0050 Task No.: 3

LIQUID APPLICATION TRENCH CAPACITY

1. OBJECTIVE

The objective of this evaluation is to estimate the rate at which leachate will infiltrate into the waste mass from the infiltration trenches at the Maplewood bioreactor project.

2. METHODOLOGY

2.1 Overview

For the analyses performed herein, gravity drainage of leachate from the infiltration structures was assumed. Liquid in the amount of 4 million gallons per year would be applied, consisting primarily of leachate. Liquid collected from the 48-acre disposal area would be recirculated in the 10-acre bioreactor area. Gravity-drained conditions will exist in the infiltration structures with the exception of the condition when leachate is injected through a forcemain and the leachate pumps are operated after the application structures are filled; in this case, a pressurized condition will exist. If desired, analysis of the pressurized condition could be performed by increasing the value of hydraulic head used in the following equations from hydrostatic head to pressure head. However, this would result in a higher infiltration capacity. To be conservative, it is assumed that unpressurized conditions will exist.

2.2 Application Trench Capacity

Application trench capacity is estimated by considering infiltration from the trench bottom and trench sides.

Infiltration Rate from Trench Bottom (q_b).

The infiltration rate from the trench bottom is estimated using the following equation [Bouwer, 1978].

$$q_b = k\left(1 + \frac{(h - P_o)}{z_f}\right) \tag{1}$$

Written by: T. B. Maier /M. Houlihan Date: 05/02/00 Reviewed by: RDE Date: 05/02 /00

Client: Waste Management, Inc. Project: Maplewood Bioreactor. Proj./Proposal No.: ME0050 Task No.: 3

z_f = 75 ft (vertical distance between the liner system and the trenches (z_f will actually vary from 0 to 75 ft))

B = 3 ft

r = 1.5 ft

2.4 Analysis Procedure

Some conservative simplifying assumptions were made before applying the preceding equations to the calculation of the capacity of the infiltration structures. Although the hydraulic head (h) and depth to wetting front (z_f) will vary as drainage from a trench progresses, the depth to the wetting front was assumed to be constant and only the variation of hydraulic head was considered. The depth to wetting front was assumed to be 75 ft (23 m), which is the distance from the bottom of a trench to the top of the leachate collection layer. This distance is effectively equal to the maximum distance to the wetting front and is representative of long-term steady-state conditions. Therefore, prior to waste saturation (i.e., when z_f reaches its maximum), the actual capacity of the liquid application structures is expected to be greater than the calculated capacity. The variation in hydraulic head was accounted for by dividing the range of hydraulic head that will occur during gravity drainage of structures into discrete intervals and calculating an average rate of liquid application for each hydraulic head interval.

3. CALCULATIONS

Convert hydraulic conductivity from units of cm/s to units of ft/day:

$$k = (2 \times 10^{-4} \text{ cm/s})\ (1 \text{ ft} / 30.48 \text{ cm})\ (8.64 \times 10^{4} \text{ s/day}) = 0.567 \text{ ft/day}$$

The calculations were performed using the spreadsheet presented below.

Drain Time for Interval: (Δh = 0.5 is used for all intervals)

$$t_i = \Delta h / (q_i)_{ave} = (0.5 \text{ ft}) / (0.604 \text{ ft/day}) = 0.83 \text{ days}$$

Total drain time is the sum of drain times for all intervals up to the maximum hydraulic head. Note that if the depth to wetting front is increased beyond 20 ft to represent greater vertical distance between groups of trenches, there is very little change to the calculated drain time (the calculated drain time increases slightly).

4. INFILTRATION SYSTEM CAPACITY

Infiltration capacity per unit area for trenches spaced every 50 ft:

Each 50 ft by 50 ft area will contain 50 linear feet of trench.

Area = 2,500 ft^2 Trench length = 50 ft Trench Length/Area = 0.05 ft/ ft^2

Liquid storage capacity per linear foot of trench (refer to Figure 3 of liquid application plan for trench dimensions):

V = (4 ft high) (3 ft wide) (1 ft long) (0.3 porosity) (7.48 gal/ft^3) = 27 gal / l.f.

From Section 3, time to drain is approximately 5 days.

Infiltration Capacity per l.f. of Trench = (27 gal / l.f.) / (5 days) = 5.4 gal / l.f. / day

Infiltration Capacity per ft^2 of Infiltration Area = (5.4 gal / l.f. / day) (0.05 ft/ ft^2)
= 0.27 gal / ft^2 / day

5. PERFORMANCE EVALUATION FOR A TYPICAL GROUP OF TRENCHES

Based on recent records of leachate generative rates from the facility, a reasonable estimate of the average leachate generation rate over the active life of the facility is 4 million gallons per year or about 10,959 gallons per day, which equals about 228 gal/ac/day for the 48-acre active disposal area. Applying this amount of leachate in a 10-acre area requires an application rate of 1,095 gallons per acre. This simple estimate will be used for the purposes of the following calculation.

Written by: T. B. Maier /M. Houlihan Date: 05/02/00 Reviewed by: RDE Date: 05/02 /00

Client: Waste Management, Inc. Project: Maplewood Bioreactor. Proj./Proposal No.: ME0050 Task No.: 3

Donohue, "*Part B Permit Application, Maplewood Recycling and Waste Disposal Facility*," prepared for Chambers Waste Systems of Virginia, Inc., by Donohue & Associates, Inc., Sheboygan, Wisconsin, May 1991.

Meier, W.R., Elnicky, E.J., and Newlin, C.W., "*Design of a Porous Pavement for Control of Highway Runoff*", Transportation Research Board 71st Annual Meeting, Paper No. 920208, 1992, 38 p.

Schroeder, P.R., McEnroe, B.M., Peyton, R.L., and Sjostrom, J.W., "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, Vol. III, User's Guide for Version 2.05*," 1988.

APPENDIX C

Revised Section 3.10 of Operations Manual

3.10 Leachate Removal

Tanker trucks will collect leachate stored in the leachate tanks on a schedule to be determined. If storage tanks are filling abnormally fast, leachate haulers shall be notified that an unscheduled collection may be necessary and suitable contingency arrangements shall be made.

Leachate may be transported to an appropriate treatment facility, which has the capability and is willing to treat landfill leachate, or otherwise disposed of as permitted by Federal, State, and County authorities. Waste Management expects to permit a leachate pretreatment facility on site in the near future. Permits for this pretreatment facility will be requested from VADEQ and from the Water Control Board. In addition, leachate recirculation will be used to manage leachate. Leachate recirculation will be performed in accordance with the Leachate Recirculation Plan for the Maplewood Recycling and Waste Disposal Facility, which has been approved by the VADEQ.

RP/CHMPARTB/AA4

APPENDIX V

Prepared for

Waste Management, Inc.
King George County Landfill
2457 Birchwood Creek Road
King George, Virginia 22484

KING GEORGE BIOREACTOR PLAN

KING GEORGE COUNTY LANDFILL AND RECYCLING FACILITY KING GEORGE, VIRGINIA

Prepared by

GEOSYNTEC CONSULTANTS
10015 Old Columbia Road, Suite A-200
Columbia, Maryland 21046

Project No. ME0169-02

May 2000

TABLE OF CONTENTS

1. PURPOSE AND INTRODUCTION

In accordance with the conditions described in Section I.F.2 of the Virginia Department of Environmental Quality (VADEQ) Solid Waste Permit No. 586 (Permit), this landfill bioreactor plan is being submitted to VADEQ to request approval to apply liquids at the King George County Landfill and Recycling Facility (KGC facility) in King George County, Virginia. This plan was prepared by Mr. Thomas B. Maier, P.E. and Mr. Michael F. Houlihan, P.E., both of GeoSyntec Consultants (GeoSyntec), Columbia, Maryland, as authorized by Mr. James W. Stenborg, P.E., of Waste Management, Inc. (Waste Management).

This landfill bioreactor plan is intended to maximize the benefits to the facility of enhancing the moisture content of the waste. The benefits of enhancing moisture content include:

- enhanced landfill gas generation;
- accelerated waste decomposition;
- improved leachate quality; and
- reduced post-closure maintenance costs.

Enhanced landfill gas generation will benefit the KGC facility because it increases the potential for developing landfill gas as a resource; it will also decrease the time during which landfill gas can cause odor or air quality problems. Accelerated waste decomposition (i.e., the conversion of degradable materials to inert compounds) will provide an increased level of environmental protection by accelerating the rate at which the waste mass becomes inert. Accelerated waste stabilization results in a shorter duration during which leachate is expected to contain relatively high concentrations of undesirable constituents, thus creating an overall improvement in leachate quality. Improved leachate quality reduces the amount and concentration of constituents that could impact ground-water quality. Liquid application will also reduce post-closure maintenance costs because accelerated waste stabilization will result in less settlement after final cover construction. The manner in which liquid application is expected to provide these benefits is described in more detail in Section 2.2.1.

2. REGULATORY OVERVIEW AND CURRENT TECHNOLOGY

2.1 Regulatory Overview

The United States Environmental Protection Agency (EPA) promulgated Subtitle D of the Resource Conservation and Recovery Act (Subtitle D) in October of 1991. The Subtitle D regulations, which are presented in Title 40 of the Code of Federal Regulations, Part 258 (40 CFR 258), are the Federal solid waste disposal facility criteria. In reference to leachate recirculation, 40 CFR 258.28(a)(2) states the following:

> "(a) Bulk or noncontainerized liquid waste may not be placed in MSWLF units <u>unless</u>... (2) The waste is leachate or gas condensate derived from the MSWLF unit and the MSWLF unit, whether it is a new or existing MSWLF, or lateral expansion, is designed with a composite liner and leachate collection system as described in § 258.40(a)(2) of this part. The owner or operator must place the demonstration in the operating record and notify the State Director that it has been placed in the operating record."

For over a decade, EPA has sponsored both laboratory and field-scale leachate recirculation studies to assess the potential of controlled recirculation as an effective solid waste management tool. Studies have indicated that controlled reapplication of leachate accelerates biological stabilization of the landfill mass [Natale and Anderson, 1986; Morelli, 1992]. As a result of increased biodegradation, gas production is also enhanced [Maier and Vasuki, 1996]. Studies have also shown that leachate recirculation does not result in higher concentrations of contaminants in leachate, but results in decreasing concentrations of contaminants [Pohland, 1975].

On a state level, the Virginia Department of Environmental Quality (VADEQ) published the Virginia Solid Waste Regulations (VR 672-20-10) on 1 June 1993 that allow for the recirculation of leachate and gas condensate into the landfill from which the liquid is generated (Section 5.1.C.17.a(1)(b)). These regulations indicate that the Commonwealth of Virginia recognizes the documented benefits of leachate recirculation.

(i.e., the production of methane) is generally the final reaction in the waste decomposition process [Young, 1995].

- Liquid application lowers the oxidation-reduction potential of the waste mass, which promotes the growth of methanogens (i.e., bacteria that produce methane).

Controlled liquid application (i.e., leachate recirculation at lined facilities with leachate collection systems) has been utilized as an effective leachate management tool at landfills in Europe, Canada, and the United States since the late 1970's. Useful data has been compiled from monitoring programs at some of these sites (e.g., raw and recirculated leachate quantity and quality, rainfall amounts, operational procedures, etc.). Descriptions of various field-scale recirculation projects are presented in Table 1. These projects provide information concerning advantages and disadvantages of various recirculation methods. These data were used to prepare guidelines for implementing the recirculation methods proposed herein.

As shown on Table 1, the most widely used recirculation methods include subsurface application (i.e., injection into wells and trenches) and surface application (i.e., spray application, surface impoundments). These methods are described in further detail in the following two subsections.

2.2.2 Subsurface Application

Liquid application wells and trenches have been used successfully at several landfills, as described on Table 1. Several of the landfills listed in Table 1 are operated by Waste Management, including the Charles City County Landfill in Charles City, Virginia. Use of application wells and trenches prevents exposure of leachate to the open air and eliminates the potential for leachate to run off from waste disposal areas. As a result, recirculation by subsurface injection is minimally impacted by wet weather conditions, and potential odors are contained.

Leachate application trenches may be constructed at several elevations within the landfill mass. Leachate application wells may be either constructed as the lifts are filled

After careful review of leachate recirculation projects that incorporate surface application techniques, Waste Management does not propose to use this method at this time. Methods considered for use under this recirculation plan are discussed in detail in Section 5.

4. LIQUID APPLICATION ANALYSIS PROCEDURES

4.1 Introduction

The purpose of this section is to discuss the factors that are expected to control the volume of liquid that can be applied and to summarize the procedures that were used to perform the analyses. The following analyses were performed to develop the methods described herein: (i) the effect of liquid application on the calculated hydraulic head acting on the liner; (ii) the rate of drainage of liquid from the application structures (LRS); and (iii) the recommended rate or quantity of liquid applied into to the structures.

4.2 Design Considerations

Design considerations that affect the ability to apply liquid to the landfill are: (i) the maximum allowable hydraulic head on the landfill liner; (ii) the quantity of liquid that will percolate from the injection structures into the waste mass; and (iii) the liquid storage capacity of the waste. Each of these factors is evaluated in this section to provide a rationale for the analyses described in the following sections. State and Federal regulations require that the hydraulic head on a landfill liner be maintained below 12 in. (300 mm). Based on the evaluation presented in Appendix A, the need to maintain the hydraulic head on the liner below 12 in. (300 mm) is the factor that will limit the volume of liquid that can be applied. The factor that will limit the cumulative volume of liquid that can be applied in excess of the field capacity of the waste mass is the seepage flowrate from the trenches and the resulting head on the liner system. These are evaluated in Appendix B.

The waste mass can absorb and retain leachate until it reaches its field capacity moisture content, which is defined in the following sentences. Field capacity is defined as the minimum moisture content that the waste mass can achieve due to gravity drainage alone. Conversely, it is the maximum moisture content at which no liquid will drain out of the waste under the influence of gravity. It is generally undesirable to saturate the waste on a long-term basis because, when the waste mass is saturated, gas extraction structures may become nonfunctional due to excess liquid accumulation and application to the waste of 0.055 in./day, and that applying leachate at this rate for the four-year period of the program will not even raise the waste to its field capacity. As calculated in Appendix B, the rate at which leachate can be applied using trenches is 5.4 gallons per linear foot of trench per day (67 L/m·d). As shown in Appendix B, the time required for waste influenced by an application trench structure to reach field capacity is approximately 7 months.

The conclusion of the performance evaluation, presented in Sections 5 and 6 of Appendix B, is that leachate can be recirculated at the average rate of 543 gallons per acre of injection area per day (20,000 L/m^2·day) without producing a hydraulic head on the liner in excess of 12 in. (300 mm). The number, size, and spacing of leachate recirculation structures in service at a given time and the rate at which leachate is injected using these structures will be selected in accordance with the criteria presented in Section 5 and determined by landfill operations personnel based on available landfill area and the actual leachate management needs of the site. In addition, it is recognized that off-site treatment of leachate may be needed and is, therefore, retained as a contingency alternative for leachate management.

5.2 Application Trench Layout

5.2.1 Overview

In this section, the following topics are addressed: (i) layout criteria; (ii) construction details; (iii) liquid application procedures; (iv) monitoring procedures; and (v) inspection procedures.

5.2.2 Layout Criteria

In order to guide operation of the application trenches in accordance with the requirements of the permit, criteria for layout and location of the application structures are provided below. The intent of these criteria is to apply leachate into the waste mass without causing leachate outbreaks, spillage, and other potential concerns related to leachate management. Injection trenches will be laid out in accordance with the following criteria.

- Trenches will be installed on relatively flat (i.e., less than 15 percent slope) areas of the landfill. Trenches will typically be parallel to elevation contours to promote uniform distribution of leachate under gravity drainage conditions. In areas with less than 2 percent slope, trenches may be placed in any direction relative to elevation contours.

- The perforated pipe in each trench will be installed having a slope between 0.25 and 0.5 percent to facilitate uniform distribution of leachate under gravity drainage conditions. The bottom of the trench may be excavated at a slope flatter than the pipe.

- The spacing between trenches will be a maximum of 100 ft (30 m). Spacing may be varied to increase or decrease the injection capacity of subsequent phases based on experience with initial phases.

- A minimum distance of 50 ft (15 m) will be maintained between the top landfill side slopes and drainage material in a given trench to eliminate the potential for leachate seeps to develop on sideslopes.

forcemain or leachate tanker truck. The coupling will be capped when not in use. Similarly, the monitoring pipes will extend 2 ft (0.6 m) or more above the landfill surface and will be fitted with removable end caps to allow access for checking the leachate levels at the various trench locations. Each trench standpipe and monitoring pipe will be identified and marked in the field. Application standpipes and monitoring pipes may be extended upward to enable their continued use after placement of an additional layer of waste.

5.2.4 Liquid Application Procedures

Liquid will be conveyed to application trenches using one or both of the following two methods: (i) transfer from the storage tanks to a tanker truck, which will drive onto the landfill and discharge directly into the standpipe of a trench; or (ii) be convey through pipes to application trenches directly from leachate collection sumps or staging tanks, which may be used to temporarily hold leachate immediately prior to being discharged to wells or trenches. One possible location for storage tanks is on top of the landfill. Leachate would not be injected during extended periods of wet weather. Liquid levels in injection structures will be monitored to determine when application is practical.

The total liquid storage capacity of the drainage material and pipe of each injection trench is approximately 27 gallons per linear foot (335 L/m) of trench based on the cross section shown on Figure 3. Based on the value of hydraulic conductivity of waste used in the HELP analyses, the time required for the designed trench to dewater is expected to be on the order of five days at the onset of recirculation and is expected to gradually increase with time. The actual percolation rate will be ultimately determined by field conditions. Based on the value of hydraulic conductivity of waste used in the HELP analyses, each trench should initially be able to drain at a rate of about 5.4 gallons per linear foot per day (67 L/m·d). Calculations of infiltration times are presented in Appendix B.

5.3 Adaptation of Liquid Application Structures for Use for Gas Extraction

Liquid application trenches may be modified in the future for use as gas extraction structures. Figure 5 presents conceptual designs for modifications to trenches. These conceptual designs may be used based on the landfill gas management needs of the facility or a need to control odors. Waste Management recognizes the potential for using the liquid application system infrastructure to assist with management of landfill gas, if needed.

7. CONCLUSIONS

This plan has been submitted in response to the requirements of Section I.F.2 of Solid Waste Permit Number 586. Upon approval from the VADEQ, USA Waste will implement the recirculation program in accordance with revised Section 6.1 (i.e., "Leachate Control and Monitoring Plan") of the Operations Manual for the KGC facility. Section 6.1 is included in Appendix C to this document. USA Waste believes that a well-managed leachate recirculation program will provide the benefits of enhanced gas generation, accelerated waste stabilization, improved leachate quality, reduced duration of time during which landfill gas is produced, and reduced post-closure maintenance. Leachate recirculation is proposed as a supplementary method of managing leachate that will be used in conjunction with direct disposal to a POTW and possible leachate evaporation, if permitted in the future. As demonstrated in Appendix A of this plan, the existing leachate collection system for the KGC facility is capable of managing both leachate from precipitation and recirculation (according to the procedures described in this plan) while maintaining compliance with the requirements of the Permit.

Meier, W.R., Elnicky, E.J., and Newlin, C.W., "*Design of a Porous Pavement for Control of Highway Runoff*", Transportation Research Board 71st Annual Meeting, Paper No. 920208, 1992, 38 p.

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Natale, B.R., and Anderson, W.C., "Evaluation of Landfill Leachate Recirculation", *Proceedings of Specialty Conference*, ASCE, Environmental Engineering Division, 8-10 July 1986.

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Reinhart, D.R., "Full-Scale Experiences with Leachate Recirculating Landfills: Case Studies", *Waste Management and Research*, Vol. 14, No. 4, p. 347-365, August 1996.

Vasuki, N.C., "Leachate Generation in a Lined Landfill: A Case Study of the Central Solid Waste Facility at Sandtown, DE", *41st Purdue University Industrial Waste Conference Proceedings*, 1986.

Vasuki, N.C., "*Landfill Test Cells*", Delaware Solid Waste Authority, 1991.

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TABLES

TABLE 1

SUMMARY OF FIELD-SCALE LEACHATE RECIRCULATION PROJECTS

Landfill Bioreactor Plan
King George County Landfill and Recycling Facility
King George, Virginia

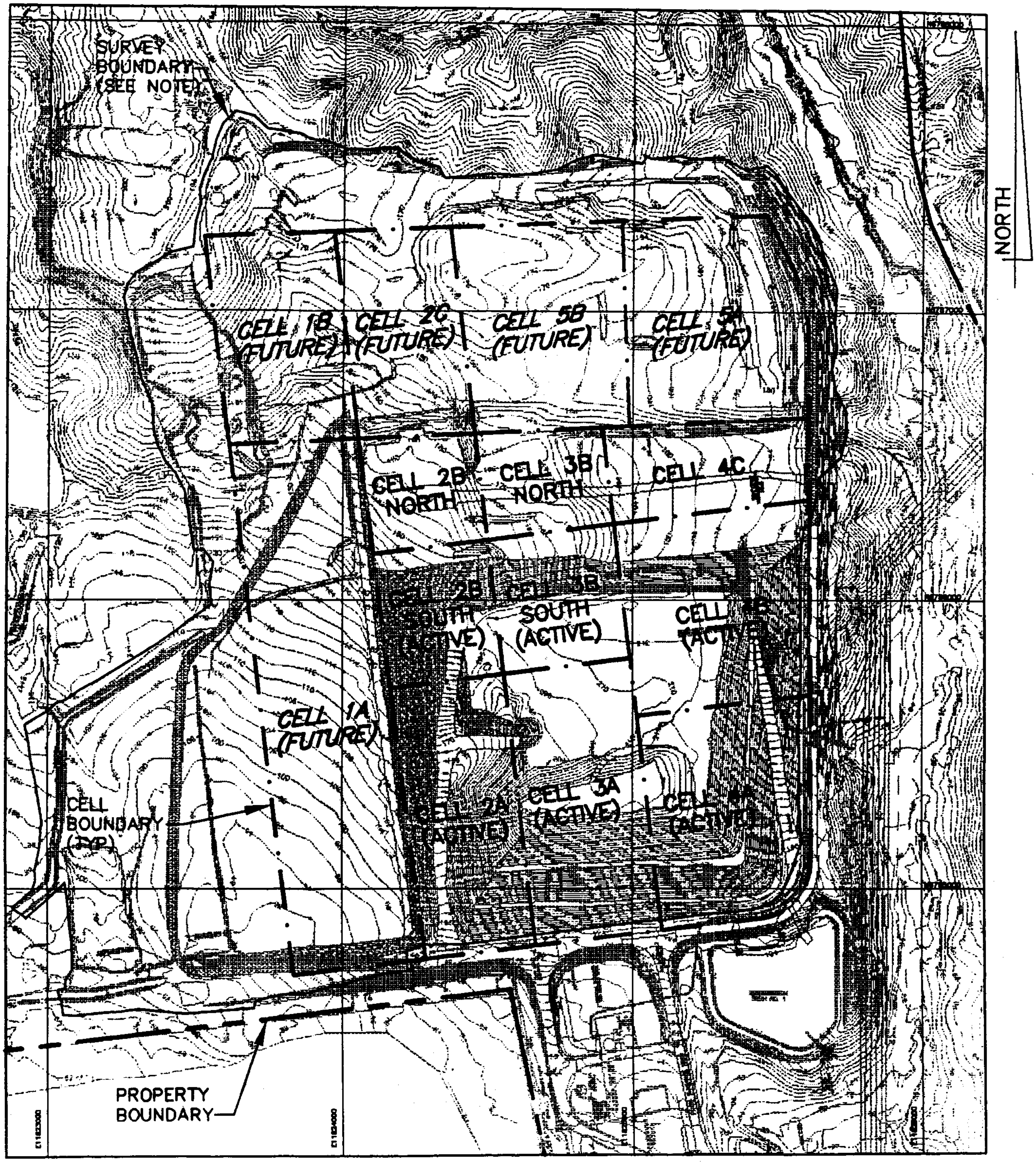
PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Yorkshire, England Searner-Carr Landfill [Robinson and Maris, 1985]	Field-Scale Study	• 6.2-acre cell used as leachate recycle area. • Approximate 6-acre control area. • Cell lined with 100-mil HDPE with leachate collection system. • 13 ft of pulverized refuse placed in cells. • Leachate redistributed by spray pipe networks laid on top of refuse. • Furrows later dug into surface to reduce ponding. • Recirculation and monitoring period approximately 3 years. • 36,000 gallons of leachate storage available.
Delaware Solid Waste Authority Central Solid Waste Management Center Sandtown, Delaware [Vasuki, 1986]	Field-Scale Study	• Leachate recycle in 2 full-scale landfill cells. • 9-acre cell using recharge wells. • 18-acre cell using four wells and traveling spray irrigation system. • Total leachate storage capacity of 40,000 gallons. • Cells lined with 30-mil PVC synthetic liner with leachate collection systems. • Average refuse depth in cells is 30 ft.
Lycoming County Landfill Williamsport, PA [Natale and Anderson, 1986]	Full-Scale Operations with Study	• Three 10-acre leachate recycle cells. • 20-mil PVC used to line cells along with leachate collection systems. • Various leachate recycle strategies attempted but not detailed. • Authors observed recharge wells to work best. • Eight years of data collection included flow measurement (collect and recycle); rainfall; landfill surface conditions (monthly); and quarterly leachate quality monitoring.
Southwest Landfill Alachua County, Florida [Reinhart, 1996] [Townsend et al., 1996]	Full-Scale Operations with Study	• Composite lined area is 27 ac (10.9 ha). • Waste was first accepted in Spring 1988. • Receives 10,000 tons/month (9,070 Mg/month) of MSW. • Maximum waste thickness will be 65 ft (20 m). • Permitted to recirculate up to 60,000 gal/day (227 m^3/day). • Storage tank capacity is 360,000 gal (1,364 m^3). • From 1990-1992, over 8 million gal (30,000 m^3) of leachate was pumped into infiltration ponds. • In 1993, began using horizontal injection trenches (horizontal spacing of 50 ft (15 m), vertical spacing of 20 ft (6 m)). • From March through September 1993, injected 200,000 to 780,000 gal/month (757 to 2,950 m^3/month) of leachate into a total of 17 injection trenches.
Central Landfill Facility Worcester County, Maryland [Reinhart, 1996] [Kilmer, 1991]	Full-Scale Operations	• Lined area consists of four 17-ac (6.9-ha) cells. • Began operating in 1990. • Maximum fill height will be 90 ft (27 m). • Receives 200 tons/day (181 Mg/day) of MSW. • Storage tank capacity is 400,000 gal (1,514 m^3). • Leachate is recirculated using one vertical discharge well for each 2-ac (0.8-ha) area.

TABLE 1
(continued)

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Mill Seat Landfill Monroe County, New York [Reinhart, 1996]	Full-Scale Operations with Study	• The bioreactor research project involves three hydraulically separated double composite lined cells varying from 5.4 to 7.4 ac (2.2 to 3 ha) in area. • One cell serves as a control (i.e., no recirculation); two different horizontal leachate injection systems are used in the other two cells. • Cell 2 has horseshoe-shaped injection trenches at three elevations, and a storage tank capacity of 20,000 gal (76 m^3). • Cell 3 has horizontal trenches at two elevations containing pre-fabricated infiltrators, and a storage tank capacity of 20,000 gal (76 m^3). • The relative moisture content of the waste will be monitored using gypsum blocks located in the waste.
Delaware Solid Waste Authority Southern Solid Waste Management Center Sussex County, Delaware [Maier and Vasuki, 1996]	Full-Scale Operations	• Leachate was recirculated in Cells 1 and 2 using vertical injection wells from 1985 to 1994. • For Cell 3, a horizontal integrated leachate recirculation and landfill gas extraction system is planned; lifts of separate injection and extraction trenches will be installed every 20 ft (3 m) vertically.
Charles City County Landfill Charles City County, Virginia [VADEQ Solid Waste Permit No. 531]	Full-Scale Operations	• Leachate is injected into horizontal trenches filled with shredded tires. • The landfill is operated by USA Waste.
Pine Bluff Landfill Cherokee County, Georgia [Georgia Solid Waste Permit No. 028-039 D (SL)]	Full-Scale Operations	• Leachate is injected into horizontal trenches. • The landfill is operated by USA Waste.
Quail Hollow Landfill Tulahoma, Tennessee [Tennessee Solid Waste Permit No. SNL-02-102-0101]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.
Cedar Ridge Landfill Louisberg, Tennessee [Tennessee Solid Waste Permit Number SNL-59-102-0238 EXT]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.
Southern Sanitation Landfill Russelville, Kentucky [Kentucky Solid Waste Permit Number 071-00006]	Full-Scale Operations	• Leachate is sprayed into the working face. • The landfill is operated by USA Waste.

FIGURES

CONCEPTUAL BIOREACTOR SYSTEM LAYOUT
KING GEORGE COUNTY LANDFILL AND RECYCLING CENTER

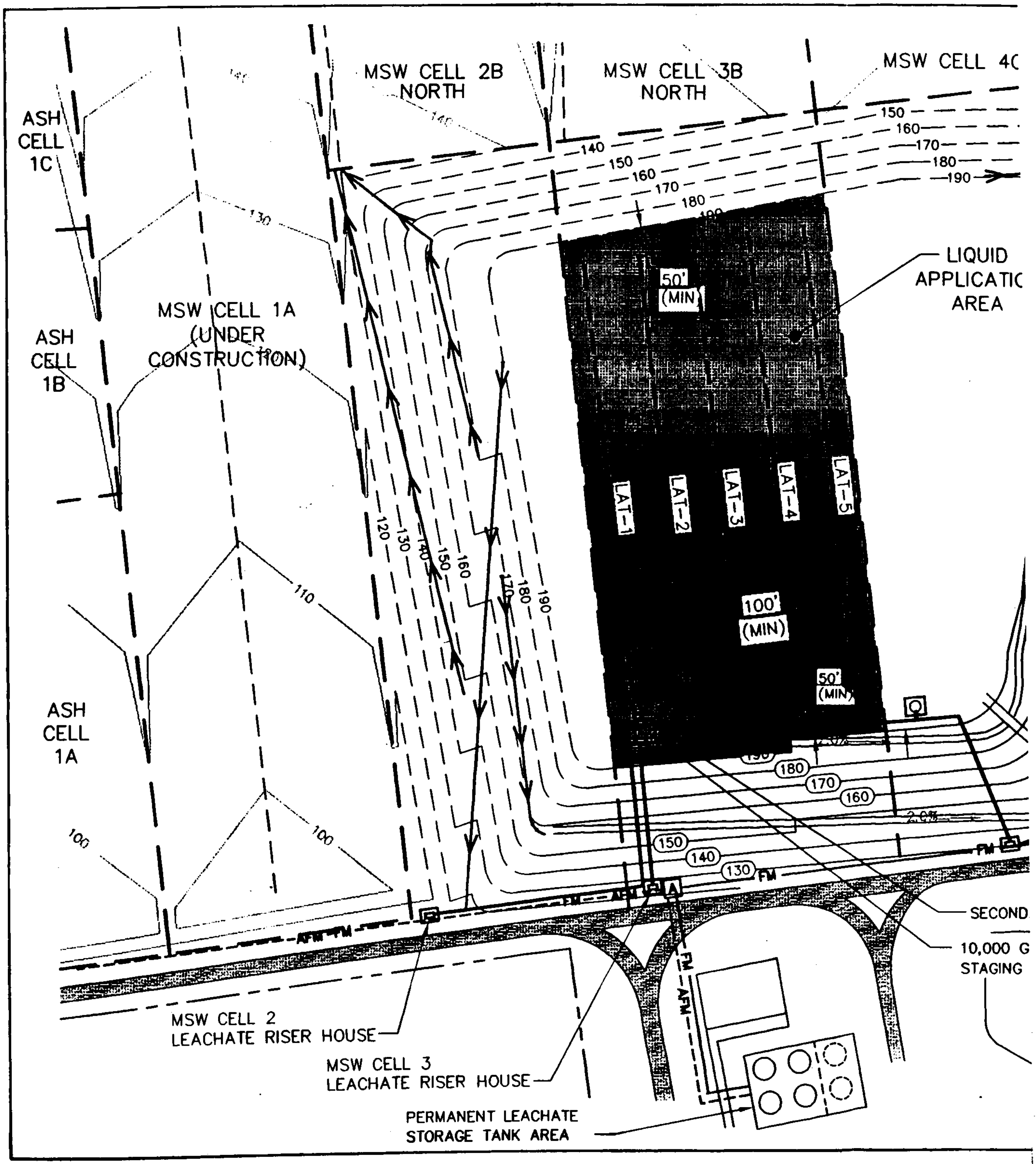


NOTE:
AREA WITHIN LINE DESIGNATED IS FROM DECEMBER 1999 SURVEY BY ________; AREA OUTSIDE THAT LINE IS FROM A PRIOR SURVEY.

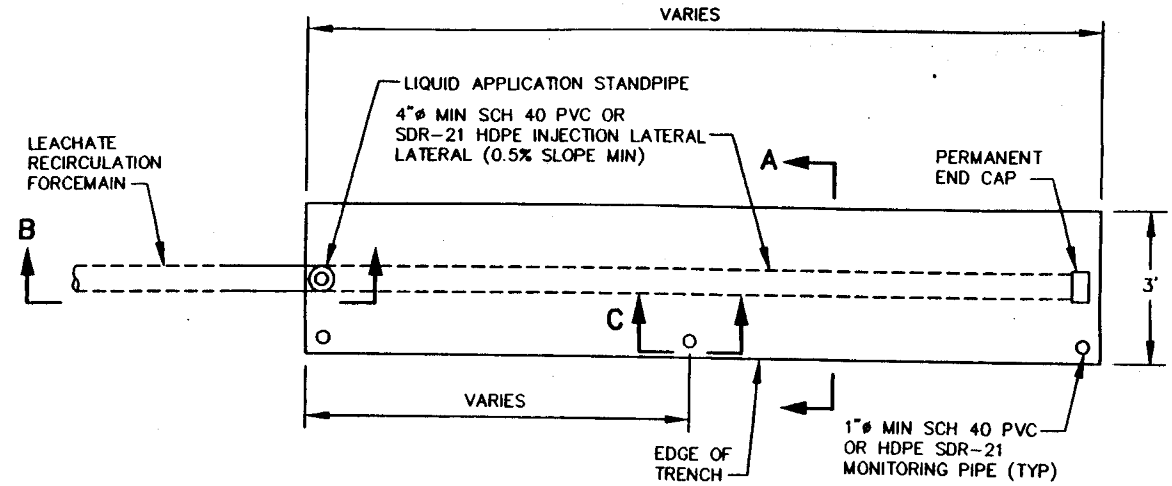
500 250 0 500
SCALE IN FEET

GeoSyntec Consultants
COLUMBIA, MARYLAND

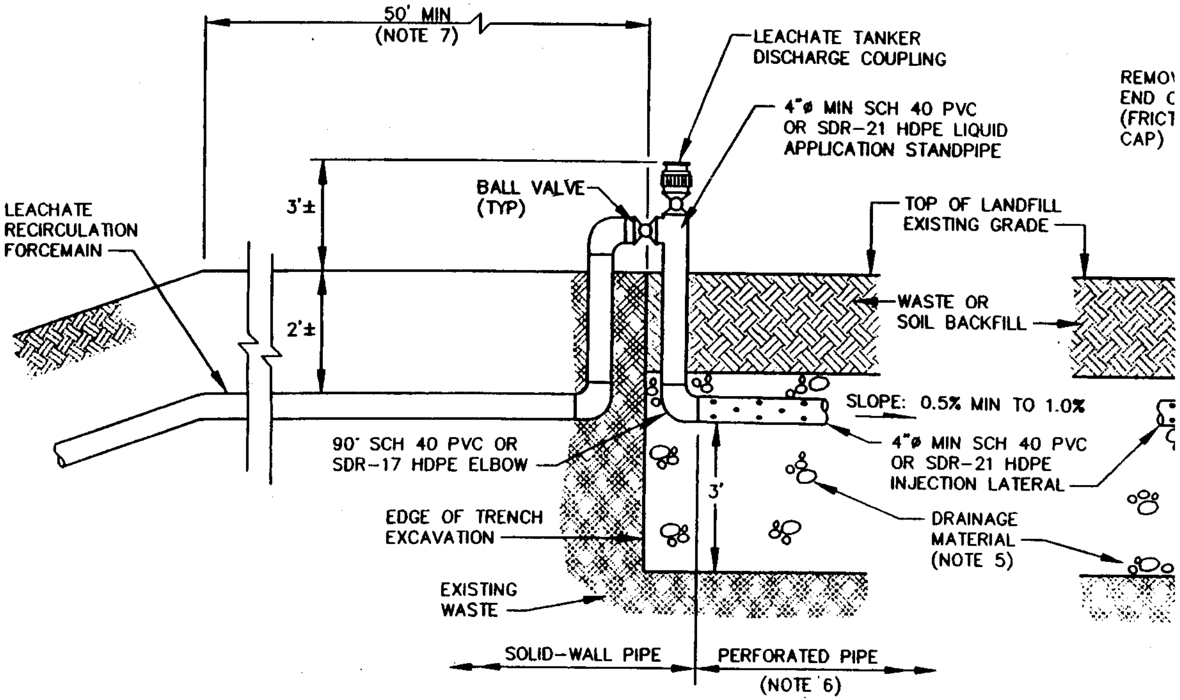
FIGURE NO.	1
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169P001



ASH CELL 1C
ASH CELL 1B
ASH CELL 1A
MSW CELL 2B NORTH
MSW CELL 3B NORTH
MSW CELL 4C
MSW CELL 1A (UNDER CONSTRUCTION)
LIQUID APPLICATIC AREA
LAT-1
LAT-2
LAT-3
LAT-4
LAT-5
50' (MIN)
100' (MIN)
50' (MIN)
SECOND
10,000 G STAGING
MSW CELL 2 LEACHATE RISER HOUSE
MSW CELL 3 LEACHATE RISER HOUSE
PERMANENT LEACHATE STORAGE TANK AREA
FM
AFM
2.0%

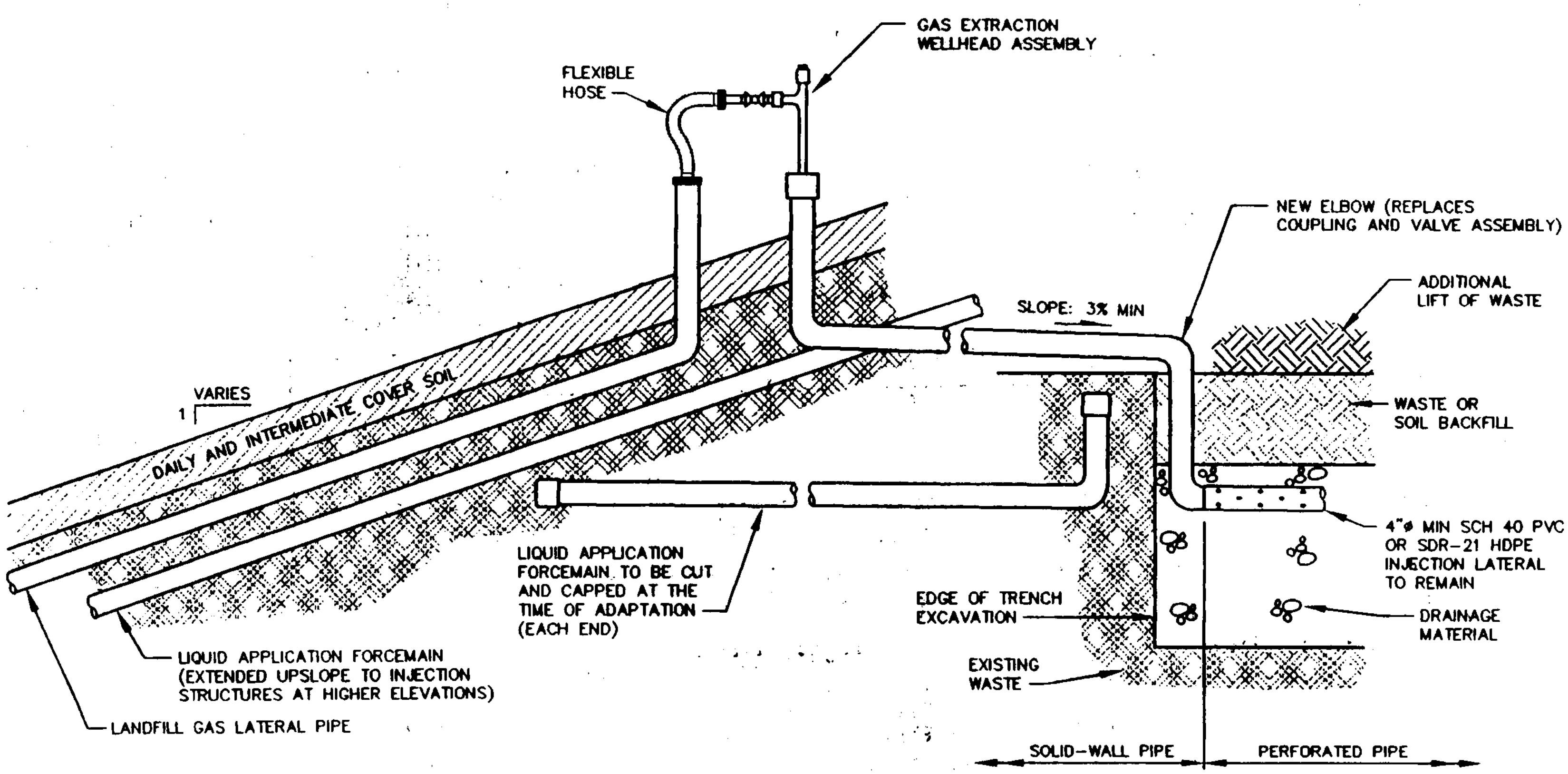


1 — PLAN
PROPOSED LIQUID APPLICATION TRENCH
NOT TO SCALE



B — SECTION B
PROPOSED LIQUID APPLICATION TRENCH AT STANDPIPE
NOT TO SCALE

C — S
P
T
N



NOT TO SCALE

NOTES:

1. THIS IS A CONCEPTUAL PLAN SHOWING ONE POSSIBLE PIPING CONFIGURATION. THE FOLLOWING ASSUMPTIONS WERE MADE:
   (i) THE TRENCH SHOWN IS NOT IN THE UPPERMOST LIFT OF WASTE; AND
   (ii) WASTE PLACEMENT IS CONTINUING AT A HIGHER ELEVATION THAN SHOWN IN THIS FIGURE.
2. WASTE MANAGEMENT MAY CHOOSE TO CONTINUE APPLYING LEACHATE INTO A TRENCH AFTER IT HAS BEEN ADAPTED FOR LANDFILL GAS EXTRACTION.

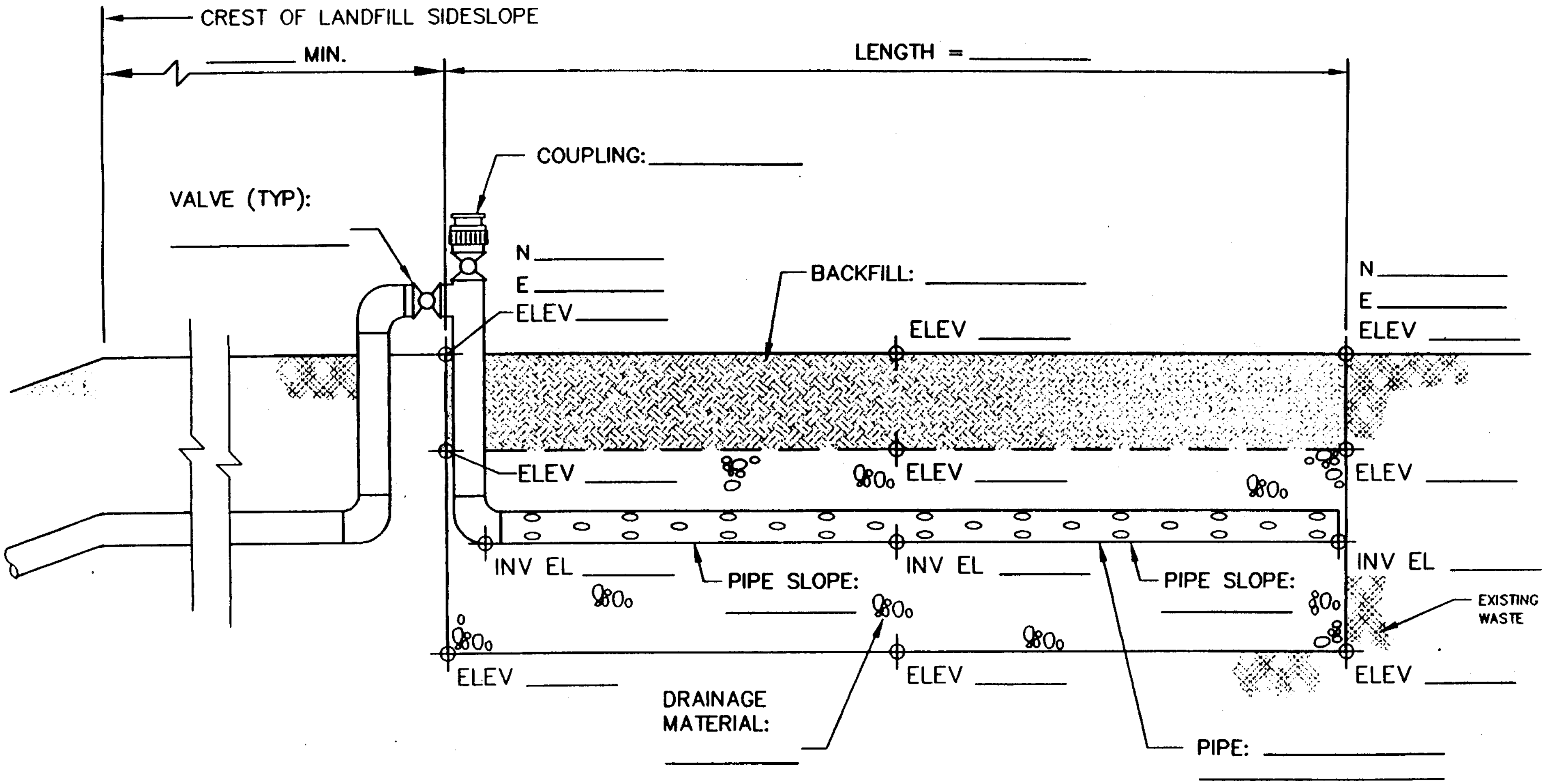
LIQUID APPLICATION TRENCH ADAPTED FOR LANDFILL GAS EXTRACTION

GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

FIGURE NO.	4
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169F004

TRENCH NO.: ____________

DATE CONSTRUCTED : ____________



NOT TO SCALE

TRENCH CONSTRUCTION LOG

GeoSyntec Consultants

COLUMBIA, MARYLAND

FIGURE NO.	5
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169F005

APPENDIX A

Evaluation of Leachate Head on Liner

COMPUTATION COVER SHEET

Client: WMI **Project:** Leach. Recirculation **Project/Proposal#:** ME0169 **Task #:** 02

TITLE OF COMPUTATIONS EVALUATION OF LEACHATE HEAD ON LINER – KING GEORGE

COMPUTATIONS BY:
Signature Douglas T. Mandeville
5/23/00
DATE
Printed Name and Title: Douglas T. Mandeville, Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature M F Houlihan
5/25/00
DATE
Printed Name and Title: Michael F. Houlihan, Principal

COMPUTATIONS CHECKED BY:
Signature M F Houlihan
5/25/00
DATE
Printed Name and Title: Michael F. Houlihan, Principal

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature Douglas T. Mandeville
5/25/00
DATE
Printed Name and Title: Douglas T. Mandeville, Staff Engineer

APPROVED BY:
(PM or Designate)
Signature M F Houlihan
5/25/00
DATE
Printed Name and Title: Michael F. Houlihan, Principal

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

ME0169/MD00117.KGC.CAL

Written by: Doug Mandeville Date: 05 / 23 / 00 Reviewed by: ______ Date: 05/30/00

Client: Waste Management, Inc. Project: KGCLF Leachate Recirc. Proj./Proposal No.: ME0169 Task No.: 2

EVALUATION OF LEACHATE HEAD ON LINER

1. OBJECTIVE

The objective of this evaluation is to estimate the effect of leachate recirculation on the hydraulic head on the liner of the King George County Landfill and Recycling Facility (King George Facility). State regulations (VR-672-20-10, Section 5.5) require that the hydraulic head on a landfill liner be maintained below 12 in. (300 mm).

2. METHODOLOGY

The methodology and input parameter values that were used are identical to those previously used by others to estimate leachate quantities for the King George Facility, as presented in Attachment 5-1 of the approved Part B Solid Waste Permit Application (Part B) [Rust 1994]. Both the previous and current evaluations were performed using the Hydrologic Evaluation of Landfill Performance (HELP) Model, version 3 [USEPA, 1994a,b]. The evaluation presented herein incorporates one modification relative to the Part B evaluation, which was required to model the effect of leachate recirculation; a constant subsurface inflow was added to the waste.

3. EVALUATION OF HYDRAULIC HEAD ON LINER

The effect of leachate recirculation on hydraulic head was evaluated for the condition of an 80-foot thickness of MSW over a 10-acre area.

The maximum anticipated rate of leachate recirculation was conservatively assumed to be 8,000,000 gallons/year. This number was based on previous leachate generation rates and includes additional water to allow the landfill to function as a bioreactor. A portion of this water will be consumed during the methanogenesis process that turns cellulose into carbon dioxide, methane and water vapor. This calculation of water consumption during biodegradation is shown below.

Written by: Doug Mandeville Date: 05 / 23 / 00 Reviewed by: ______ Date: 05/30/00

Client: Waste Management, Inc. Project: KGCLF Leachate Recirc. Proj./Proposal No.: ME0169 Task No.: 2

net inflow = 8,000,000 - 2,500,000 = 5,500,000 gallons/year ;

5,500,000 gallons/year over 10 acres = 550,000 gallons/acre/year

= 550,000 gallons/acre/year x 12 inches/foot x gallon/7.48 ft^3 x acre/43560 ft^2
= 20.25 in/year.

This is accounted for in the HELP analysis by adding a subsurface inflow to layer 2 of 20.25 inches per year.

4. RESULTS AND CONCLUSIONS

The HELP output for this analysis is shown starting on page 4 of this calculation package. The peak daily head on the liner is 0.410 inches. This is less than maximum amount of head of 12 inches that is allowed on the liner.

5. REFERENCES

Leszkiewicz, J.J., and McAulay, P.B., "Municipal Solid Waste Landfill Bioreactor Technology: Closure and Postclosure Issues", US Environmental Protection Agency Seminar Publication: Landfill Bioreactor Design and Operation, EPA/600/R-95/146, USEPA, Washington, DC, September 1995.

USEPA, "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, Vol. I, Users Guide for Version 3*", EPA/530-SW-84-009, US Environmental Protection Agency, Washington, DC, June 1994a, 120p.

USEPA, "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, Vol. II, Users Guide for Version 3*", EPA/530-SW-84-010, US Environmental Protection Agency, Washington, DC, June 1994b, 120p.

Rust, "*King George County Landfill and Recycling Facility, King George County, Virginia, Part B Solid Waste Permit Application*", prepared by Rust Environment and Infrastructure, Bensalem, Pennsylvania, August 1994.

```
THICKNESS                   =      12.00   INCHES
POROSITY                    =       0.4300 VOL/VOL
FIELD CAPACITY              =       0.3663 VOL/VOL
WILTING POINT               =       0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.4300 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999997000E-06 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

```
SCS RUNOFF CURVE NUMBER              =     91.61
FRACTION OF AREA ALLOWING RUNOFF     =      0.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000   ACRES
EVAPORATIVE ZONE DEPTH               =     10.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      3.268   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.930   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      2.150   INCHES
INITIAL SNOW WATER                   =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS     =    249.697   INCHES
TOTAL INITIAL WATER                  =    249.697   INCHES
TOTAL SUBSURFACE INFLOW              =     20.25    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RICHMOND VIRGINIA

```
STATION LATITUDE                          =  37.50 DEGREES
MAXIMUM LEAF AREA INDEX                   =   0.00
START OF GROWING SEASON (JULIAN DATE)     =   103
END OF GROWING SEASON (JULIAN DATE)       =   303
EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  68.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  77.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  73.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RICHMOND VIRGINIA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.53	1.81	2.89	1.92	3.60	3.82
4.56	4.95	3.03	2.54	3.41	3.66

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RICHMOND VIRGINIA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
32.10	36.80	46.10	55.40	63.40	72.50
76.10	74.20	68.00	55.90	48.40	38.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RICHMOND VIRGINIA
AND STATION LATITUDE = 37.50 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.65	1.94	3.10	2.06	3.92	4.11
	4.89	5.31	3.26	2.73	3.66	3.93
STD. DEVIATIONS	0.18	0.79	1.32	1.39	2.11	1.84
	0.94	1.47	1.09	1.98	1.04	2.71
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.039	1.492	2.666	2.257	3.372	3.564
	4.495	3.134	2.538	2.052	1.750	0.979
STD. DEVIATIONS	0.307	0.531	0.316	0.884	1.406	1.438
	0.649	1.190	0.773	0.789	0.536	0.192
SUBSURFACE INFLOW INTO LAYER 2						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.5721	0.8262	0.9611	0.9806	0.8554	0.8937
	0.7237	0.9361	0.8487	0.8105	1.0366	0.6383
STD. DEVIATIONS	0.7414	1.3135	1.4433	1.3617	1.1581	1.2371
	0.9705	1.2641	1.0396	0.9278	1.2076	0.8062
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0004	0.0006	0.0006	0.0006	0.0006	0.0006
	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.45	8893.500
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	0.13585	493.15057
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000039	0.14285
AVERAGE HEAD ON TOP OF LAYER 4	0.210	
MAXIMUM HEAD ON TOP OF LAYER 4	0.410	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	5.2 FEET	
DRAINAGE COLLECTED FROM LAYER 5	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000	
MAXIMUM HEAD ON TOP OF LAYER 6	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	2.20	7995.6484

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4203

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2150

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****

****

FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	2.2101	0.3683
2	347.1888	0.3617
3	0.8796	0.0489
4	0.0000	0.0000
5	1.2405	0.1034
6	5.1600	0.4300
SNOW WATER	0.000	

****
****

APPENDIX B

Liquid Application Structure Capacity

Written by: T. B. Maier /M. Houlihan Date: 05/02/00 Reviewed by: RDE Date: 05/02 /00

Client: Waste Management, Inc. Project: King George Landfill Bioreactor Proj./Proposal No.: ME0050 Task No.: 3

LIQUID APPLICATION TRENCH CAPACITY

1. OBJECTIVE

The objective of this evaluation is to estimate the rate at which liquid will infiltrate into the waste mass from the infiltration trenches at the King George bioreactor program.

2. METHODOLOGY

2.1 Overview

For the analyses performed herein, gravity drainage of liquid from the infiltration structures was assumed. Liquid in the amount of 7 to 8 million gallons per year would be applied, which would consist of leachate plus stormwater. Leachate collected from the active 61-acre disposal area would all be recirculated the 10-acre bioreactor area. Gravity-drained conditions are assumed to exist in the infiltration structures with the exception of the condition when leachate is injected through a forcemain and the leachate pumps are operated after the application structures are filled; in this case, a pressurized condition will exist. If desired, analysis of the pressurized condition could be performed by increasing the value of hydraulic head used in the following equations from hydrostatic head to pressure head. However, this would result in a higher infiltration capacity. To be conservative, it is assumed that unpressurized conditions will exist.

2.2 Application Trench Capacity

Application trench capacity is estimated by considering infiltration from the trench bottom and trench sides.

Infiltration Rate from Trench Bottom (q_b).

The infiltration rate from the trench bottom is estimated using the following equation [Bouwer, 1978].

$$q_b = k\left(1 + \frac{(h - P_o)}{z_f}\right) \qquad (1)$$

z_f = 75 ft (vertical distance between the liner system and the trenches (z_f will actually vary from 0 to 75 ft))

B = 3 ft

r = 1.5 ft

2.4 Analysis Procedure

Some conservative simplifying assumptions were made before applying the preceding equations to the calculation of the capacity of the infiltration structures. Although the hydraulic head (h) and depth to wetting front (z_f) will vary as drainage from a trench progresses, the depth to the wetting front was assumed to be constant and only the variation of hydraulic head was considered. The depth to wetting front was assumed to be 75 ft (23 m), which is the distance from the bottom of a trench to the top of the leachate collection layer. This distance is effectively equal to the maximum distance to the wetting front and is representative of long-term steady-state conditions. Therefore, prior to waste saturation (i.e., when z_f reaches its maximum), the actual capacity of the liquid application structures is expected to be greater than the calculated capacity. The variation in hydraulic head was accounted for by dividing the range of hydraulic head that will occur during gravity drainage of structures into discrete intervals and calculating an average rate of liquid application for each hydraulic head interval.

3. CALCULATIONS

Convert hydraulic conductivity from units of cm/s to units of ft/day:

$$k = (2 \times 10^{-4} \text{ cm/s}) (1 \text{ ft} / 30.48 \text{ cm}) (8.64 \times 10^{4} \text{ s/day}) = 0.567 \text{ ft/day}$$

The calculations were performed using the spreadsheet presented below.

Drain Time for Interval: (Δh = 0.5 is used for all intervals)

$$t_i = \Delta h / (q_i)_{ave} = (0.5 \text{ ft}) / (0.604 \text{ ft/day}) = 0.83 \text{ days}$$

Total drain time is the sum of drain times for all intervals up to the maximum hydraulic head. Note that if the depth to wetting front is increased beyond 20 ft to represent greater vertical distance between groups of trenches, there is very little change to the calculated drain time (the calculated drain time increases slightly).

4. INFILTRATION SYSTEM CAPACITY

Infiltration capacity per unit area for trenches spaced every 50 ft:

Each 50 ft by 50 ft area will contain 50 linear feet of trench.

Area = 2,500 ft^2 Trench length = 50 ft Trench Length/Area = 0.05 ft/ ft^2

Liquid storage capacity per linear foot of trench (refer to Figure 3 of liquid application plan for trench dimensions):

V = (4 ft high) (3 ft wide) (1 ft long) (0.3 porosity) (7.48 gal/ft^3) = 27 gal / l.f.

From Section 3, time to drain is approximately 5 days.

Infiltration Capacity per l.f. of Trench = (27 gal / l.f.) / (5 days) = 5.4 gal / l.f. / day

Infiltration Capacity per ft^2 of Infiltration Area = (5.4 gal / l.f. / day) (0.05 ft/ ft^2)
= 0.27 gal / ft^2 / day

5. PERFORMANCE EVALUATION FOR A TYPICAL GROUP OF TRENCHES

Based on recent records of leachate generative rates from the facility, a reasonable estimate of the average leachate generation rate over the active life of the facility is about 4 million gallons per year, or about 10,959 gallons per day, which equals a leachate generation rate of about 180 gal/ac/day. Assuming a total quantity of liquid application of 8 million gallons per year, the total quantity of liquid applied would be equal to 2,200 gallons per acre per day. This simple estimate will be used for the purposes of the following calculation.

Written by: T. B. Maier/M. Houlihan Date: 05/02/00 Reviewed by: RDE Date: 05/02/00

Client: Waste Management, Inc. Project: King George Landfill Bioreactor Proj./Proposal No.: ME0050 Task No.: 3

7. REFERENCES

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APPENDIX C

Revised Section 6.1 of Operations Manual

6. CONTROL AND MONITORING OF LIQUIDS AND GAS

6.1 LEACHATE CONTROL AND MONITORING PLAN

The leachate collection system has been designed to ensure that under normal operations, no more than 12 inches of leachate will be present above the low point of the liner at any time. It is recognized that there may be periods of unusually high rainfall events that could cause the head on the liner to exceed 12 inches for a short period (less than 7 days) of time until the leachate pumps evacuate the liquid off the liner. Leachate is removed from the cells by submersible pumps and transported to above ground holding tanks via a forcemain. The holding tanks are of a capacity sufficient to hold 7 days of leachate. Leachate will be discharged from the storage tanks to trucks or rail cars for transport to an offsite treatment facility.

At the time of discharge to the trucks, samples will be taken to be analyzed for parameters specified by the treatment facility. Results of these analyses will be forwarded to the treatment facility and maintained in the landfill operating records. Furthermore, leachate recirculation will be used to manage leachate and decomposition of waste. Leachate recirculation will be performed in accordance with the contents of the Department-approved document entitled, *"Leachate Recirculation Plan for the King George County Landfill and Recycling Facility"*, prepared by GeoSyntec Consultants, 3 July 1997. It is anticipated that the leachate storage tanks will eventually be piped for discharge to a local treatment plant. Under normal operating conditions, leachate from MSW and ash cells will be segregated in separate storage tanks because of potentially different treatment requirements. The ability to pump into and load out from either storage tank is provided.

Back-up leachate storage pump shall be available at all times.